

# University of Mumbai



No. AAMS\_UGS/ICC/2022-23/ 181

## CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to the syllabus uploaded by Academic Authority Meetings & Services which was accepted by the Academic Council at its meeting held on 14<sup>th</sup> July, 2016 vide item No. 4.19 relating to the revised syllabus as per Choice Based Credit System for M.E. (Mechanical) Energy Systems and Management.

You are hereby informed that the recommendations made by the Board of Studies in **Mechanical Engineering** at its meeting held on 31<sup>st</sup> May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5<sup>th</sup> July, 2022 vide item No. 6.58 (R) have been accepted by the Academic Council at its meeting held on 11<sup>th</sup> July, 2022 vide item No. 6.58 (R) and that in accordance therewith, the revised syllabus of **M.E. (Energy System and Management) (Sem.- I to IV) (CBCS) (REV - 2022 Scheme)**, has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website [www.mu.ac.in](http://www.mu.ac.in)).

MUMBAI - 400 032  
19<sup>th</sup> November, 2022

  
(Prof. Sunil Bhirud)  
I/c Registrar

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.58 (R)/11/07/2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Board of Studies in Mechanical Engineering,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Information & Communication Technology,
- 6) The Co-ordinator, MKCL.

**Copy to :-**

- 1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
- 2. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 5. The Deputy Registrar, Executive Authorities Section (EA),**
- 6. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 7. The Deputy Registrar, (Special Cell),**
- 8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
- 9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

**They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.**

- 1. P.A to Hon'ble Vice-Chancellor,**
- 2. P.A Pro-Vice-Chancellor,**
- 3. P.A to Registrar,**
- 4. All Deans of all Faculties,**
- 5. P.A to Finance & Account Officers, (F.& A.O),**
- 6. P.A to Director, Board of Examinations and Evaluation,**
- 7. P.A to Director, Innovation, Incubation and Linkages,**
- 8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
- 9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
- 10. The Director of Board of Student Development,**
- 11. The Director, Department of Students Welfare (DSD),**
- 12. All Deputy Registrar, Examination House,**
- 13. The Deputy Registrars, Finance & Accounts Section,**
- 14. The Assistant Registrar, Administrative sub-Campus Thane,**
- 15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
- 16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 17. The Assistant Registrar, Constituent Colleges Unit,**
- 18. BUCTU,**
- 19. The Receptionist,**
- 20. The Telephone Operator,**
- 21. The Secretary MUASA**

**for information.**

# **University of Mumbai**



**Revised Syllabus for**

**M.E.**

**(Energy System & Management)**

**Semester – (I to IV)**

**(Choice Based Credit System)**

**(With effect from the academic year 2022-23)**



6.58

## University of Mumbai



|                                        |                                             |
|----------------------------------------|---------------------------------------------|
| O: _____ Title of Course               | <b>M.E. (Energy Systems and Management)</b> |
| O: _____ Eligibility                   | Ordinance 0.5134                            |
| R: _____ Passing Marks                 | 45%                                         |
| No. of years/Semesters:                | 4 semesters                                 |
| Level:                                 | P.G. / U.G./Diploma / Certificate           |
| Pattern:                               | Yearly / Semester                           |
| Status:                                | New / Revised                               |
| To be implemented from Academic Year : | With effect from Academic Year : 2022-23    |

**Dr. Vivek Sunnapwar**  
Chairman  
of Board of Studies in Mechanical  
Engineering

**Dr. Suresh K. Ukarande**  
Associate Dean,  
Faculty of Science and Technology

**Dr Anuradha Majumdar**  
Dean,  
Faculty of Science and  
Technology

## **Preamble**

Education in engineering is growing in India and is expected to increase by a factor of several in the near future. The current situation presents a significant challenge in terms of ensuring quality to stakeholders while expanding. To face this challenge, the problem of quality must be addressed, debated, and progressed in a methodical manner. Accreditation is the primary form of quality assurance in higher education, and it signifies that the institution or programme of study is committed to meeting certain minimum stated requirements and is available to external assessment in order to get recognition. The main goal of this accrediting procedure is to assess the outcomes of the programme being evaluated. Program outcomes are a collection of skills and information that a student will possess upon completion of the programme. In keeping with this, the University of Mumbai's Faculty of Science and Technology has taken the lead in implementing the principle of outcome-based education into the curriculum building process.

We are pleased to report that the Postgraduate Program Educational Objectives were completed in a brainstorming session attended by more than 20 members from the University's associated institutes. They were either department heads or senior faculty from the Mechanical Engineering Department. The Program Educational Objectives finalized for the postgraduate program in Mechanical Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To prepare the Learner to use modern tools effectively in order to solve real life problems.
3. To prepare the Learner for a successful career in Indian and Multinational Organisations
4. To encourage and motivate the Learner in the art of self-learning.
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to the aforementioned, linked Institutes may add 2 to 3 additional programme instructional objectives of their own. In addition to Program Educational Objectives, each course in a postgraduate program's curriculum includes objectives and expected outcomes from the perspective of the learner to support the idea of outcome-based education. We are convinced that even a tiny move in the correct manner will go a long way toward ensuring that the main stakeholders receive high-quality education.

Dr. S. K. Ukarande  
Associate Dean  
Faculty of Science and Technology  
University of Mumbai

Dr Anuradha Muzumdar  
Dean  
Faculty of Science and Technology  
University of Mumbai

## **Preface**

To tackle the challenge of assuring engineering education excellence, the problem of quality must be addressed, debated, and progressed in a methodical manner. Accreditation is the primary way of ensuring the quality of higher education. The main goal of the certification procedure is to determine how good a company is. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development.

Faculty of Science and Technology, University of Mumbai, in one of its meetings collectively resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs), give freedom to Affiliated Institutes to add few (PEOs), course objectives course outcomes to be clearly defined for each course, so that all faculty members in linked institutes are aware of the depth of approach to the subject to be given, so improving the learning process of students It was also decided that while changing the curriculum, the most senior academics from institutions and industry specialists should be included.

We are happy to state that the Board of studies has adhered to the resolutions passed by Faculty of Technology and developed curriculum accordingly. In addition to outcome-based education, Choice Based Credit System is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System allows for a much-needed shift in education focus from teacher-centric to learner-centric, since the workload estimate is based on time spent learning rather than teaching. It also emphasises constant evaluation, which will improve educational quality. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy, adopting a ten-point scale to grade learner's performance. REV-2022 scheme is implemented for Master of Engineering from the academic year 2022-2023.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

### **Board of Studies in Mechanical Engineering**

|                        |            |
|------------------------|------------|
| Dr. Vivek K. Sunnapwar | : Chairman |
| Dr. S. M. Khot         | : Member   |
| Dr. V. M. Phalle       | : Member   |
| Dr. Siddappa Bhusnoor  | : Member   |
| Dr. S.S. Pawar         | : Member   |
| Dr. Sanjay U. Bokade   | : Member   |
| Dr. Dhanraj Tambuskar  | : Member   |
| Dr. V. B. Tungikar     | : Member   |
| Dr. K.P. Karunakaran   | : Member   |
| Dr. S. S. Thipse       | : Member   |
| Dr. Milind Deshmukh    | : Member   |

## Semester I

| Course Code | Course Name                                             | Teaching Scheme (Contact Hours) |        |      | Credits Assigned |                         |           |              |       |
|-------------|---------------------------------------------------------|---------------------------------|--------|------|------------------|-------------------------|-----------|--------------|-------|
|             |                                                         | Theory                          | Pract. | Tut. | Theory           | Pract.                  | Tut.      | Total        |       |
| ESMC101     | Energy Scenario, Policy and Environment                 | 3                               | --     | --   | 3                | --                      | --        | 3            |       |
| ESMC102     | Energy Efficiency in Thermal Systems                    | 3                               |        | --   | 3                |                         | --        | 3            |       |
| ESMPE101    | Program Elective 1                                      | 3                               | --     | --   | 3                | --                      | --        | 3            |       |
| ESMPE102    | Program Elective 2                                      | 3                               | --     | --   | 3                | --                      | --        | 3            |       |
| ESMIE101    | Institute Elective 1                                    | 3                               | --     | --   | 3                | --                      | --        | 3            |       |
| ESML101     | Program Lab-IEnergy System Modelling and Simulation Lab | --                              | 2      | --   | --               | 1                       | --        | 1            |       |
| ESMSBL 101  | Skill Based Lab-IEnergy Audit Lab                       | --                              | 4      | --   | --               | 2                       | --        | 2            |       |
| Total       |                                                         | 15                              | 06     | --   | 15               | 03                      | --        | 18           |       |
| Course Code | Course Name                                             | Examination Scheme              |        |      |                  |                         |           |              |       |
|             |                                                         | Theory                          |        |      |                  |                         | Term Work | Pract / Oral | Total |
|             |                                                         | Internal Assessment             |        |      | End Sem. Exam    | Exam. Duration (in Hrs) |           |              |       |
|             |                                                         | Test-1                          | Test-2 | Avg  |                  |                         |           |              |       |
| ESMC101     | Energy Scenario, Policy and Environment                 | 20                              | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMC102     | Energy Efficiency in Thermal Systems                    | 20                              | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMPE101 X  | Program Elective 1                                      | 20                              | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMPE102 X  | Program Elective 2                                      | 20                              | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMIE101    | Institute Elective 1                                    | 20                              | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESML101 X   | Program Lab-IEnergy System Modelling and Simulation Lab | --                              | --     | --   | --               | --                      | 25        | 25           | 50    |
| ESMSBL 101  | Skill Based Lab-IEnergy Audit Lab                       | --                              | --     | --   | --               | --                      | 50        | 50           | 100   |
| Total       |                                                         | --                              | --     | 100  | 400              | --                      | 75        | 75           | 650   |

## Semester I

| Program Elective 1 |                                              | Program Elective 2 |                                      |
|--------------------|----------------------------------------------|--------------------|--------------------------------------|
| Course Code        | Course Name                                  | Course Code        | Course Name                          |
| <b>ESMPE1011</b>   | Utilization of Solar Energy                  | <b>ESMPE1021</b>   | Alternative Fuels                    |
| <b>ESMPE1012</b>   | Cogeneration and Waste Heat Recovery Systems | <b>ESMPE1022</b>   | Energy Systems Modeling and Analysis |
| <b>ESMPE1013</b>   | Conventional Power Plants                    | <b>ESMPE1023</b>   | Bio Mass and Wind Energy             |

## Semester-I

| Institute Level Optional Courses (ILOC) |                                             |
|-----------------------------------------|---------------------------------------------|
| Course Code                             | Course Name                                 |
| <b>ESMIE1011</b>                        | Product Life cycle Management               |
| <b>ESMIE1012</b>                        | Reliability Engineering                     |
| <b>ESMIE1013</b>                        | Management Information System               |
| <b>ESMIE1014</b>                        | Design of Experiments                       |
| <b>ESMIE1015</b>                        | Operation Research                          |
| <b>ESMIE1016</b>                        | Cyber Security and Laws                     |
| <b>ESMIE1017</b>                        | Disaster Management and Mitigation Measures |
| <b>ESMIE1018</b>                        | Energy Audit and Management                 |

## Semester II



| Course Code | Course Name                                              | Teaching Scheme(Contact Hours) |        |      | Credits Assigned |                         |           |              |       |
|-------------|----------------------------------------------------------|--------------------------------|--------|------|------------------|-------------------------|-----------|--------------|-------|
|             |                                                          | Theory                         | Pract. | Tut. | Theory           | Pract.                  | Tut.      | Total        |       |
| ESMC201     | Advances in Energy Management and Audit                  | 3                              | --     | --   | 3                | --                      | --        | 3            |       |
| ESMC202     | Energy Efficiency in Electrical Systems                  | 3                              |        | --   | 3                |                         | --        | 3            |       |
| ESMPE201X   | Program Elective 3                                       | 3                              | --     | --   | 3                | --                      | --        | 3            |       |
| ESMPE202X   | Program Elective 4                                       | 3                              | --     | --   | 3                | --                      | --        | 3            |       |
| ESMIE201X   | Institute Elective 2                                     | 3                              | --     | --   | 3                | --                      | --        | 3            |       |
| ESML201     | Program Lab-II Measurement & Virtual Instrumentation Lab | --                             | 2      | --   | --               | 1                       | --        | 1            |       |
| ESMSBL 201  | Skill Based Lab-II Renewable Energy Lab                  | --                             | 4      | --   | --               | 2                       | --        | 2            |       |
| Total       |                                                          | 15                             | 06     | --   | 15               | 03                      | --        | 18           |       |
| Course Code | Course Name                                              | Examination Scheme             |        |      |                  |                         |           |              |       |
|             |                                                          | Theory                         |        |      |                  |                         | Term Work | Pract / Oral | Total |
|             |                                                          | Internal Assessment            |        |      | End Sem. Exam    | Exam. Duration (in Hrs) |           |              |       |
|             |                                                          | Test-1                         | Test-2 | Avg  |                  |                         |           |              |       |
| ESMC201X    | Advances in Energy Management and Audit                  | 20                             | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMC202     | Energy Efficiency in Electrical Systems                  | 20                             | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMPE201    | Program Elective 3                                       | 20                             | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMPE202    | Program Elective 4                                       | 20                             | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESMIE201    | Institute Elective 2                                     | 20                             | 20     | 20   | 80               | 3                       | --        | --           | 100   |
| ESML201     | Program Lab-II Measurement & Virtual Instrumentation Lab | --                             | --     | --   | --               | --                      | 25        | 25           | 50    |
| ESMSBL 201  | Skill Based Lab-II Renewable Energy Lab                  | --                             | --     | --   | --               | --                      | 50        | 50           | 100   |
| Total       |                                                          | --                             | --     | 100  | 400              | --                      | 75        | 75           | 650   |

**Note 1:** Skill Based Lab- I and II are focused on the learning through experience. SBL shall facilitate the learner to acquire the fundamentals of practical engineering in his or her specialization in a project-oriented environment. The learning through skill-based labs can be useful in facilitating their research work and hence useful in early completion of their dissertation work.

## Semester II

| Program Elective 1 |                                        | Program Elective 2 |                                              |
|--------------------|----------------------------------------|--------------------|----------------------------------------------|
| Course Code        | Course Name                            | Course Code        | Course Name                                  |
| <b>ESMPE2011</b>   | Renewable & Sustainable Energy Systems | <b>ESMPE2021</b>   | Energy Measurement and Control Instruments   |
| <b>ESMPE2012</b>   | Energy Storage Systems                 | <b>ESMPE2022</b>   | Energy Systems & Environmental Impact        |
| <b>ESMPE2013</b>   | Fuels Combustion and Emission Control  | <b>ESMPE2023</b>   | Materials And Devices for Energy Application |

## Semester–II

| Institute Level Optional Courses (ILOC) |                                             |
|-----------------------------------------|---------------------------------------------|
| Course Code                             | Course Name                                 |
| <b>ESMIE2011</b>                        | Project Management                          |
| <b>ESMIE2012</b>                        | Finance Management                          |
| <b>ESMIE2013</b>                        | Entrepreneurship Development and Management |
| <b>ESMIE2014</b>                        | Human Resource Management                   |
| <b>ESMIE2015</b>                        | Professional Ethics and CSR                 |
| <b>ESMIE2016</b>                        | Research Methodology                        |
| <b>ESMIE2017</b>                        | IPR and Patenting                           |
| <b>ESMIE2018</b>                        | Digital Business Management                 |
| <b>ESMIE2019</b>                        | Environmental Management                    |

### Semester III

| Course Code | Course Name                    | Teaching Scheme (Contact Hours) |        |      | Credits Assigned |                         |           |             |       |
|-------------|--------------------------------|---------------------------------|--------|------|------------------|-------------------------|-----------|-------------|-------|
|             |                                | Theory                          | Pract. | Tut. | Theory           | Pract.                  | Tut.      | Total       |       |
| ESMMP301    | Major Project: Dissertation -I | --                              | 20     | --   | --               | 10                      | --        | 10          |       |
| Total       |                                | 00                              | 20     | 00   | 00               | 10                      | --        | 10          |       |
| Course Code | Course Name                    | Examination Scheme              |        |      |                  |                         |           |             |       |
|             |                                | Theory                          |        |      |                  |                         | Term Work | Pract/ Oral | Total |
|             |                                | Internal Assessment             |        |      | End Sem. Exam    | Exam. Duration (in Hrs) |           |             |       |
|             |                                | Test-1                          | Test-2 | Avg  |                  |                         |           |             |       |
| ESMMP301    | Major Project: Dissertation -I | --                              | --     | --   | --               | --                      | 100       | --          | 100   |
| Total       |                                | --                              | --     | --   | --               | --                      | 100       | --          | 100   |

### Online Credit Courses

| Course Code  | Course Name               | Teaching Scheme (Contact Hours) |           |           | Credits Assigned |           |           |           |
|--------------|---------------------------|---------------------------------|-----------|-----------|------------------|-----------|-----------|-----------|
|              |                           | Theory                          | Pract.    | Tut.      | Theory           | Pract.    | Tut.      | Total     |
| ESMOCC 301   | Online Credit Course - I  | --                              | --        | --        | --               | --        | --        | 3         |
| ESMOCC 301   | Online Credit Course - II | --                              | --        | --        | --               | --        | --        | 3         |
| <b>Total</b> |                           | <b>--</b>                       | <b>--</b> | <b>--</b> | <b>00</b>        | <b>00</b> | <b>00</b> | <b>06</b> |

**Note 2:** It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL / Swayam /MOOC or similar platform approved by UoM. These two courses shall be completed in any semester I or II or III, but not later end of the Semester III. University shall make a provision that credits earned with OCC- I and OCC-II shall be accounted in the third semester grade-sheet with actual names of courses. The learner shall be allowed to take up these courses from his or her institute or organisation/ industry where his / her major project is carried out. The students shall complete the courses and shall qualify the exam conducted by the respective authorities/ instructor from the platform. The fees for any such courses and the corresponding examination shall be borne by the learner.

#### Online Credit Course – I

The learner shall opt for the course in the domain of Research Methodology or Research & Publication Ethics or IPR. The opted course shall be of 3 credits of equivalent number of weeks.

#### Online Credit Course –II

The learner shall opt for the course recommended by Faculty Advisor/ Project Supervisor from the institute. The opted course shall be of 3 credits of equivalent number of weeks.

## Semester IV

| Course Code | Course Name                     | Teaching Scheme (Contact Hours) |        |      | Credits Assigned |                         |           |             |       |
|-------------|---------------------------------|---------------------------------|--------|------|------------------|-------------------------|-----------|-------------|-------|
|             |                                 | Theory                          | Pract. | Tut. | Theory           | Pract.                  | Tut.      | Total       |       |
| ESMMP401    | Major Project: Dissertation -II | --                              | 32     | --   | --               | 16                      | --        | 16          |       |
| Total       |                                 | --                              | 32     | --   | --               | 16                      | --        | 16          |       |
| Course Code | Course Name                     | Examination Scheme              |        |      |                  |                         |           |             |       |
|             |                                 | Theory                          |        |      |                  |                         | Term Work | Pract/ Oral | Total |
|             |                                 | Internal Assessment             |        |      | End Sem. Exam    | Exam. Duration (in Hrs) |           |             |       |
|             |                                 | Test-1                          | Test-2 | Avg  |                  |                         |           |             |       |
| ESMMP401    | Major Project: Dissertation -II | --                              | --     | --   | --               | --                      | 100       | 100         | 200   |
| Total       |                                 | --                              | --     | --   | --               | --                      | 100       | 100         | 200   |

**Total Credits: 68**

**Note 3:** The Dissertation -II submission shall not be permitted till the learner completes all the requirements ME course.

**Note 4:** The contact hours for the calculation of load of the teacher for Major Project are as follows:  
Major Project Dissertation I and II - 02 Hour / week / student

### Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format. Guidelines for Assessment of Dissertation-I.

Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

### Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/International conference/Journal of repute.

Dissertation II should be assessed by internal and External Examiners appointed by the University of Mumbai.



| Course Code    | Course Name                                    | Credits   |
|----------------|------------------------------------------------|-----------|
| <b>ESMC101</b> | <b>Energy Scenario, Policy and Environment</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |         |         |              |                          |                          |    |    |       |
|---------------------|---------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |         |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |         |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2   | Average |              |                          |                          |    |    |       |
| 20                  | 20      | 20      |              |                          |                          |    |    |       |
| 80                  | 03 Hrs. | --      | --           | --                       | 100                      |    |    |       |

### Objectives

1. To understand and compare global and Indian energy profile.
2. To compare global and Indian energy policies.
3. To analyze energy impact on environment.

**Outcomes:** Learner will be able to...

1. Assess role of energy in global economic development.
2. Analyze energy consumption pattern in India and its effect on economic development.
3. Determine impact of international energy policy on national energy growth.
4. Understand relationship between energy, ecology and environment.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Hrs.      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Global Energy Scenario</b><br>Role of energy in economic development and social transformation, Energy & GDP, GNP and its dynamics. Energy sources and overall energy demand and availability, Energy Consumption in various sectors and its changing pattern, Exponential increase in energy consumption and projected future demands. Non-Conventional and Conventional Energy Resources: Coal, Oil, Natural Gas, Nuclear Power and Hydroelectricity, Solar, wind and other renewable etc. Depletion of energy sources and impact on exponential rise in energy consumption on economies of countries and on international relations. Energy Security, Energy Consumption and its impact on environmental climatic change | <b>08</b> |
| <b>II</b>  | <b>Indian Energy Scenario</b><br>Energy resources & Consumption, Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India and their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.<br>Impact of Energy on Economy, Development and Environment, Energy for Sustainable Development, Energy and Environmental policies, need for use of new and renewable energy sources, present status and future of nuclear and renewable energy, Energy Policy Issues related Fossil Fuels, Renewable Energy, Power sector reforms, restructuring of energy supply sector, energy strategy for future.           | <b>08</b> |
| <b>III</b> | <b>International Energy Policy</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>06</b> |

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|           | International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EU Countries. International Energy Treaties (Rio, Montreal, Kyoto), Conference of Parties (COP), INDO-US Nuclear Deal. Future Energy Options, Sustainable Development, Energy Crisis, Role of International Energy Agency.                                                                                                                                                                                                                                                                    |           |
| <b>IV</b> | <b>Indian Energy Policy</b><br>Global energy issues, National & State level energy issues, National & State energy policy, Industrial energy policy, Energy security, Energy vision. Energy pricing & Impact of global variations. Energy productivity (National & Sector wise productivity). Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Frame work of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & SERCs), Role of MoP (Ministry of Power) and BEE (Bureau of Energy Efficiency). | <b>06</b> |
| <b>V</b>  | <b>Industrial Energy and Environment Analysis</b><br>Energy and the environment, Energy in manufacture, Hazardous waste management in Chemical/Petrochemical/Cement industries and Power Plants, Contamination of ground water, Treatment & disposal, Pollution from combustion and atmospheric pollution control methods.                                                                                                                                                                                                                                                    | <b>05</b> |
| <b>VI</b> | <b>Energy, Ecology and Environment</b><br>Energy Conservation, Energy Efficiency, Concept of environment and ecology, various natural cycles in environment and ecology, effect of human activities on environment and ecology. Environmental Impact Assessment, Methodologies for environmental pollution prevention. Rules, regulations, laws etc. regarding environmental protection, pollution prevention and control, waste disposal etc. Role of government, semi/quasi govt. and voluntary organizations.                                                              | <b>05</b> |

### Assessment:

#### Internal:

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

#### End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

### References:

1. General Aspects of Energy Management and Energy Audit, Book 1, Bureau of Energy Efficiency India.
2. O'Callaghan Paul, Energy Management, McGraw Hill Book company, London, 1993.
3. A.P. Sincero, and G.A. Sincero, Environmental Engineering, Prentice Hall, New Jersey, 1996.
4. C.J., Barrow, Developing the Environment, Longman Scientific and Technical U.K., 1995.
5. R.Socolow, C. Andrews, F. Berkhout and V. Thomas, Industrial Ecology and Global change, Cambridge University Press, 1994.
6. Jose Goldemberg, A K N Reddy, Thomas Johnson, Energy for a sustainable world, Prienceton University
7. B V Desai, Energy policy, Weiley Eastern

8. J K Parikh, Modeling approach to long term demand and energy implication, IIASA Professional Paper
9. TEDDY Year Book Published by Tata Energy Research Institute (TERI),
10. S Rao, Energy Technology, Khanna Publishers
11. International Energy Outlook -EIA annual Publication
12. A.W. Culp, Principles of Energy Conversion, McGraw Hill International edition
13. Frank P Lees, Loss Prevention in Process Industries Volume 1, 2 & 3, Elsevier Butterworth Heinemann

| Semester I     |                                             |           |
|----------------|---------------------------------------------|-----------|
| Course Code    | Course Name                                 | Credits   |
| <b>ESMC102</b> | <b>Energy Efficiency in Thermal Systems</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To understand conventional and nonconventional fuels & combustion technology.
2. To discover energy conservation (ENCON) opportunities in thermal systems.
3. To know alternatives for waste energy recovery from energy systems.

**Outcomes:** Learner will be able to...

1. Define the reasons of incomplete combustion and attempt to reduce the subsequent impact.
2. Determine ENCON opportunities in thermal systems.
3. Measure and improve the quality of recovered waste energy.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                       | Hrs.      |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Fuel and Combustion Technology</b><br>Introduction to Fuels, Properties of Fuel oil, Coal and Gas, Storage, handling and preparation of fuels, Principles of Combustion, Combustion of Oil, Coal, and Gas, Biomass. <b>Calculation of theoretical air quantity, Excess air and CO<sub>2</sub> in flu gas.</b>                                                                        | <b>06</b> |
| <b>II</b>  | <b>Steam Systems and ENCON opportunities</b><br>Properties of steam, Steam distribution losses, Steam leakages, <b>Steam Pipe Sizing</b> and Design, Selection, Operation, Maintenance & Testing of Steam Traps, Condensate and flash steam recovery, Energy conservation (ENCON) opportunities in steam systems                                                                        | <b>08</b> |
| <b>III</b> | <b>Boilers and ENCON Opportunities</b><br>IBR boiler specifications, Fire tube, water tube, packaged, stoker fired boiler, Combustion in boilers, <b>Direct &amp; Indirect Method to find boiler efficiency</b> , Blow down types & <b>performance calculations</b> , Feed water treatment, ENCON opportunities, Case study, Fluidized bed combustion (FBC) boiler types and advantages | <b>08</b> |

|           |                                                                                                                                                                                                                                                                                            |           |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>IV</b> | <b>Furnace and ENCON Opportunities</b><br>Types of furnaces, Heat transfer, Losses in furnace, <b>Direct &amp; Indirect Method to find Efficiency of furnace</b> , Excess air, Heat distribution, Temperature control, Draft control General fuel economy measures in furnaces, Case study | <b>06</b> |
| <b>V</b>  | <b>Insulation and Refractories</b><br>Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractories, Heat loss.                                                                   | <b>05</b> |
| <b>VI</b> | <b>Cogeneration (CG) &amp; Waste Heat Recovery (WHR)</b><br>Definition, need & principle of CG, technical options of CG, CG cycles, Selection of CG systems, Performance evaluation of CG, Case study, Need of WHR, Waste sources and Quality, Benefits of WHR.                            | <b>05</b> |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### **References:**

1. Energy efficiency in thermal utilities, Book 2, Bureau of Energy Efficiency India.
2. Energy performance assessment for equipment & utility systems, Book 4, Bureau of Energy Efficiency India.
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
6. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press



## Program Elective 1

| Semester I       |                                    |           |
|------------------|------------------------------------|-----------|
| Course Code      | Course Name                        | Credits   |
| <b>ESMPE1011</b> | <b>Utilization of Solar Energy</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To understand Solar Geometry and basic idea of solar energy collection
2. To learn different utilities of solar energy
3. To summarize economics of solar energy collection systems

### Outcomes: Learner will be able to...

1. Estimate and quantify available solar radiation
2. Judiciously design the solar energy collection system
3. Understand basic economics of solar energy systems

| Module     | Detailed Contents                                                                                                                                                                                                                                                                      | Hrs.      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | Description of Solar Radiation and its application for thermal utilities as well as PV utilities, availability, measurement and estimation; Isotropic and anisotropic models; empirical relations                                                                                      | <b>08</b> |
| <b>II</b>  | Flat plate collector, concentrating collector, thermal energy storage: steady state and dynamic analysis, process economics                                                                                                                                                            | <b>06</b> |
| <b>III</b> | Solar water heating: active and passive, building heating and cooling, solar drying, solar desalination, Solar Ponds, Industrial Process heating                                                                                                                                       | <b>05</b> |
| <b>IV</b>  | Simulation in solar process design, limitations of simulation, design of active systems by f-chart, utilizability method                                                                                                                                                               | <b>06</b> |
| <b>V</b>   | Solar photovoltaic systems, PV generators: characteristics and models, load characteristics and direct coupled systems, maximum power point trackers, applications, design procedure, applications of nano materials/technology in solar energy                                        | <b>08</b> |
| <b>VI</b>  | Solar Economics: Application of economic methods to analyze the feasibility of solar systems to decide project/policy alternatives, Net energy analysis and cost requirements for active and passive heating and cooling, electric power generation and for industrial process heating | <b>06</b> |

## **Assessment:**

### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

### **References:**

1. S. P. Sukhatme and J K Nayak, **Solar Energy - Principles of thermal collection and storage**, 3<sup>rd</sup> Ed Tata McGraw-Hill, New Delhi.
2. J. A. Duffie and W. A. Beckman, **Solar Engineering of Thermal Processes**, 2<sup>nd</sup> Ed, John Wiley, New York, 1991.
3. D. Y. Goswami, F. Kreith and J. F. Kreider, **Principles of Solar Engineering**, Taylor and Francis, Philadelphia, 2000.
4. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, **Solar Passive Building: science and design**, Pergamon Press, New York, 1986.
5. M. A. S. Malik, G. N. Tiwari, A. Kumar and M.S. Sodha, **Solar Distillation**, Pergamon Press, New York, 1982.
6. Soteris A. Kalogirou, **Solar Energy Engineering: Processes and Systems**, Academic Press, 2009

## Program Elective 1

| Semester I       |                                                     |           |
|------------------|-----------------------------------------------------|-----------|
| Course Code      | Course Name                                         | Credits   |
| <b>ESMPE1012</b> | <b>Cogeneration and Waste Heat Recovery Systems</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To understand cogeneration and waste heat recovery techniques
2. Learn to check viability of cogeneration and waste heat recovery
3. To summarize economics of such systems

**Outcomes:** Learner will be able to...

1. Estimate and quantify available waste heat
2. Tap opportunities of waste heat recovery
3. Understand economics of cogeneration and waste heat recovery systems

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                           | Hrs.      |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Cogeneration:</b> Introduction - Principles of Thermodynamics - Combined Cycles Topping - Bottoming - Organic Rankine Cycles - Advantages of Cogeneration Technology                                                                                                                                                     | <b>06</b> |
| <b>II</b>  | <b>Application &amp; Techno Economics of Cogeneration:</b> Cogeneration Application in various process industries. Sizing of waste heat boilers - Performance calculations, Part load characteristics selection of Cogeneration Technologies – Financial considerations - Operating and Investments - Costs of Cogeneration | <b>08</b> |
| <b>III</b> | <b>Waste Heat Recovery:</b> Introduction - Principles of Thermodynamics and Second Law - sources of Waste Heat recovery - Diesel engines and Power Plant etc. Vapour Absorption systems working on waste heat                                                                                                               | <b>07</b> |

|    |                                                                                                                                                                                                                                                                                                                                                                                |    |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| IV | <b>Waste Heat Recovery Systems:</b> Recuperators - Regenerators – economizers – Plate Heat Exchangers - Waste Heat Boilers-Classification, Location, Service Conditions, Design Considerations, Unfired combined Cycle – supplementary fired combined cycle - fired combined cycle - fluidized bed heat exchangers - heat pipe exchangers - heat pumps - thermic fluid heaters | 06 |
| V  | <b>Applications &amp; Techno Economics of Waste Heat Recovery Systems:</b><br>Applications in industries, selection of waste heat recovery technologies – financial considerations, saving potentials of different waste heat sources – operations and investment costs of waste heat recovery                                                                                 | 05 |
| VI | <b>Introduction to tri-generation and quad-generation</b>                                                                                                                                                                                                                                                                                                                      | 04 |

### Assessment:

#### Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### References:

1. Charles H. Butler, **Cogeneration**, McGraw Hill Book Co., 1984.
2. Horlock JH, **Cogeneration-Heat and Power: Thermodynamics and Economics**, Oxford, 1987.
3. Institute of Fuel, London, **Waste Heat Recovery**, Chapman & Hall Publishers, London, 1963.
4. Sengupta Subrata, Lee SS EDS, **Waste Heat Utilization and Management**, Hemisphere, Washington, 1983.
5. De Nevers, Noel., **Air Pollution Control Engineering**, McGrawHill, New York, 1995.
6. I. Pilatowsky, R.J. Romero, C.A. Isaza, S.A. Gamboa, P.J. Sebastian, W. Rivera, **Cogeneration Fuel Cell-Sorption Air Conditioning Systems** (Green Energy and Technology), Springer
7. **BEE Reference Book No 2 and 4**, BEE India

## Program Elective 1

| Semester I       |                                 |           |
|------------------|---------------------------------|-----------|
| Course Code      | Course Name                     | Credits   |
| <b>ESMPE1013</b> | <b>Conventional Power Plant</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To conduct detailed analysis of power plant cycles.
2. To understand the advancement in conventional energy systems.
3. To conduct economic analysis of energy systems.

**Outcomes:** Learner will be able to...

1. Distinguish between energy & power and understand power plant cycles in detail.
2. Understand steam systems and steam power plant installation, operation, maintenance, and life cycle economics.
3. Understand power plant installation, operation, maintenance, and life cycle economics.
4. Learn the advantages and disadvantages of combined operation of power plants.

| Module     | Detailed Contents                                                                                                                                                                                                                                               | Hrs.      |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Introduction</b><br>Energy and Power, Principal types of power plants, Power plant cycles and their classification, Performance Evaluation of Power plant cycles.                                                                                            | <b>06</b> |
| <b>II</b>  | <b>Steam Power Plants</b><br>Classification, Layout, Essential requirements of Power Station Design, Site Selection, Capacity, Plant arrangement, Useful life of SPP components, SPP pumps, Advantages and Disadvantages, Cost and Economics of SPP             | <b>08</b> |
| <b>III</b> | <b>Gas Turbine Power Plants</b><br>General aspects, Advantages and Disadvantages of GTPP over SPP, Site selection, Classification of GTPP, GTPP fuels, Operation of GTPP, GTPP layout, Effect of operating variables on thermal efficiency, Combined GT and SPP | <b>08</b> |
| <b>IV</b>  | <b>Hydro-Electric Power Plants (HePP)</b><br>Advantages and disadvantages, Site selection, Essential features/elements of HePP, Classification, Plant layout, Average life of HePP components,                                                                  | <b>06</b> |

|    |                                                                                                                                                                                                                                                                                                      |    |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|    | Electrical and Mechanical components, Comparison of HePP and SPP, Underground HePP, Advanced HePP, Safety measures and preventive maintenance, Cost of HePP and hydroelectric power                                                                                                                  |    |
| V  | <b>Nuclear Power Plants</b><br>General aspects, Nuclear power systems, Main components of NPP, Advantages of NPP, Site selection, Applications, Economics of NPP, Safety measures for NPP, Future of NPP, Nuclear Power Plants in India, Useful byproducts of Nuclear power generator and their uses | 06 |
| VI | <b>Combined Operation of Plants</b><br>General aspects, Advantages of COP, Load division and power stations, Coordination of different power plants, Cost comparison and cost analysis of SPP, GTPP, HePP and NPP                                                                                    | 05 |

### Assessment:

#### Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project or Visit to Non-conventional/conventional Power Plant.

#### End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### References:

1. El-Walkil M M, Power Plant Engineering, McGraw Hill, New York, 1985
2. Power Plant Familiarization, Manual of Central Training Resources Unit of NTPC India, 1991
3. P K Nag, Power Plant Engineering, TMH, New Delhi, 1998
4. A K Raja, Amit Praksh Shrivastava, Manish Dwivedi, Power Plant Engineering, New Age International Publishers
5. M G Jog, Hydro-Electric and Pumped Storage Plants, New Age International Publishers

## Program Elective 2

| Semester I       |                          |           |
|------------------|--------------------------|-----------|
| Course Code      | Course Name              | Credits   |
| <b>ESMPE1021</b> | <b>Alternative Fuels</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To understand socioeconomic and environment aspects of alternative fuels.
2. To get knowledge of production of alternative fuels.
3. To learn the need for fuel substitution and subsequent benefits.

### Outcomes: Learner will be able to...

1. To distinguish between types of alternative fuels.
2. To determine the quality of biofuels.
3. To analyze the impact of alternative fuels on environment.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                     | Hrs.      |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Fossil Fuels to Alternative Fuels</b><br>Reserves of Fossil fuels in India and globe, Disadvantages of Fossil fuels, Need of Alternative fuels, Types, Advantages, Sources of Alternative fuels.                                                                                   | <b>06</b> |
| <b>II</b>  | <b>Advanced Liquid Biofuels</b><br>Raw material for biofuel production, Biomass and Waste, First and next generation biofuels, Conversion of lignocellulosic, algal biomass, and waste into biofuels and chemicals, Production of Biodiesel, Bio alcohol, Jatropha Fuel Applications. | <b>08</b> |
| <b>III</b> | <b>Advanced Gaseous Biofuels</b><br>Bio-CNG from sugarcane, Synthetic gas SynGas, generation of SynGas through plasma gasification of plastic waste, Applications.                                                                                                                    | <b>06</b> |
| <b>IV</b>  | <b>Hydrogen Technology</b><br>Hydrogen as Alternative fuel, Hydrogen storage, hydrogen liquefaction, ortho and para hydrogen, Non-fossil Natural gas and methane, Applications.                                                                                                       | <b>06</b> |
| <b>V</b>   | <b>Fuel Cells</b><br>Principle & operation of Fuel cells, Thermodynamics of fuel cells, types of fuel cells, comparison of fuel cell technologies, stack configurations and fuel cell systems, Applications.                                                                          | <b>06</b> |
| <b>VI</b>  | <b>Alternative Fuels and Environmental Impact</b><br>Climate change, Benefits of alternative fuel to environment, Environmental impact assessment.                                                                                                                                    | <b>04</b> |



## **Assessment:**

### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

### **References:**

1. Sunggyu Lee, **Alternative Fuels**, Applied Energy Technology Series, CRC Press
2. Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka, **Handbook of Alternative Fuel Technologies**, CRC Press
3. Vishwanathan B and M AuliceScibioh, **Fuel Cells**, Universities Press, Hyderabad, 2006
4. Gupta R B, **Hydrogenfuel:Production, transport and storage**, Boca Raton : CRC Press, 2008
5. **Fuel Cell System**, edited by Leo J.M.J. Blomen and michael N. Mugerwa, New York, Plenum Press, 1993.
6. Michael Frank Hordiski, **Alternative Fuels-The Future of Hydrogen**, The Fairmont Press, Inc., CRC Press
7. G.N. Tiwari, M.K. Ghosal, **Fundamentals of Renewable Energy Sources**, Alpha Science Intl. Ltd., 2007
8. PrabirBasu; **Biomass gasification and pyrolysis: Practical design and theory**; Elsevier, 2010
9. Sergio Capareda, **Introduction to Biomass Energy Conversions**, CRC Press, 2013
10. H S Mukunda, **Understanding Clean Energy and Fuels from Biomass**, Wiley India
11. Sobh Nath Singh, **Non-Conventional Energy Resources**, Pearson Education
12. Nijaguna, B.T., **Biogas Technology**, New Age International publishers (P) Ltd.
13. Alternative Fuel, Edited by MaximinoManzanera, ISBN 978-953-307-372-9, Publisher InTech, Published August 09, 2011 under CC BY-NC-SA, Edited Volume, Open Access, <http://www.intechopen.com/books/alternative-fuel>

## Program Elective 2

| Semester I       |                                             |           |
|------------------|---------------------------------------------|-----------|
| Course Code      | Course Name                                 | Credits   |
| <b>ESMPE1022</b> | <b>Energy Systems Modeling and Analysis</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      |              |                          |                          |    |    |       |
|                     |       |         | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To model and simulate the energy systems for performance improvement analysis.
2. To apply quantitative techniques for optimization of operating parameters in energy system.
3. To use economic techniques for energy model development.

**Outcomes:** Learner will be able to...

1. Understand model development process and its application in energy systems.
2. Apply quantitative technique in energy systems planning, operation and maintenance.
3. Simulate the conventional and sustainable energy systems.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                      | Hrs.      |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Modeling overview</b><br>Levels of analysis, steps in model development, examples of models, Need for Energy System Modeling.                                                                                                                                                                                                                                       | <b>04</b> |
| <b>II</b>  | <b>Quantitative techniques</b><br>Interpolation-polynomial, Lagrangian, Curve fitting, regression analysis, solution of transcendental equations.                                                                                                                                                                                                                      | <b>06</b> |
| <b>III</b> | <b>Systems Simulation</b><br>Information flow diagram, solution of set of nonlinear algebraic equations, successive substitution, Newton Raphson. Examples of energy systems simulation. Numerical solution of Differential equations- Overview, Convergence, Accuracy. Transient analysis- application example                                                        | <b>08</b> |
| <b>IV</b>  | <b>Optimization</b><br>Objectives/constraints, problem formulation. Unconstrained problems- Necessary & Sufficiency conditions. Constrained Optimization- Lagrange multipliers, constrained variations, Kuhn-Tucker conditions, Linear Programming - Simplex tableau, pivoting, sensitivity analysis. Dynamic Programming. Search Techniques Univariate / Multivariate | <b>08</b> |
| <b>V</b>   | Case studies of optimization in Energy systems problems. Dealing with uncertainty probabilistic techniques. Trade-offs between capital & energy using Pinch Analysis                                                                                                                                                                                                   | <b>06</b> |
| <b>VI</b>  | Energy- Economy Models: Scenario Generation, Input Output Model                                                                                                                                                                                                                                                                                                        | <b>04</b> |

**Assessment:****Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

**References:**

1. Yogesh Jaluria, Design and Optimization of Thermal Systems, McGraw-Hill international editions, 1998
2. Stoecker W F, Design of Thermal Systems, Mcgraw Hill, 1981
3. S.S.Rao, Optimisation Theory and Applications, Wiley Eastern, 1990
4. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall, 1988
5. P. Meier, Energy Systems Analysis for Developing Countries, Springer Verlag, 1984
6. R.de Neufville, Applied Systems Analysis, Mcgraw Hill, International Edition, 1990
7. Beveridge and Schechter, Optimisation Theory and Practice, Mcgraw Hill, 1970

## Program Elective 2

| Semester I       |                                |           |
|------------------|--------------------------------|-----------|
| Course Code      | Course Name                    | Credits   |
| <b>ESMPE1023</b> | <b>Biomass and Wind Energy</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

**Outcomes:** Learner will be able to...

1. Understand potential and scope of biomass energy.
2. Understand and design thermochemical and biochemical biomass energy conversion systems.
3. Understand and analyse wind resource and wind energy statistics.
4. Understand and apply wind turbine design methods.

| Module     | Detailed Contents                                                                                                                                                                                                               | Hrs.      |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Biomass Resources</b><br>Indian national program- thrust areas of MNRE; economics aspects; Biomass types and availability in India; properties- calorific value, proximate and ultimate analysis                             | <b>04</b> |
| <b>II</b>  | <b>Thermochemical Conversion of Biomass</b><br>Methods of combustion in boilers, pyrolysis- for char, oil and gas; air gasification- types of gasifiers; thermal and engine applications of producer gas                        | <b>06</b> |
| <b>III</b> | <b>Bio Chemical Conversion</b><br>Biogas production by anaerobic digestion-fixed dome, floating dome plants; bio-methanation of liquid effluents; ethanol production from sugarcane juice and corn; biogas and ethanol as fuels | <b>07</b> |
| <b>IV</b>  | <b>Wind Energy</b><br>Wind and its Structure- Weibull and Rayleigh Statistics- Measurements and data presentation; wind turbine power curve                                                                                     | <b>07</b> |
| <b>V</b>   | <b>Aerodynamics</b><br>Aerodynamics- Linear momentum Theory- Betz limit, torque and thrust; Basic Aerodynamics- Airfoil lift and drag force for HAWT- Blade element Theory                                                      | <b>06</b> |
| <b>VI</b>  | VAWTs, wind turbine applications, economics of wind farms                                                                                                                                                                       | <b>04</b> |

## **Assessment:**

### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

### **References:**

1. J. Twidell and T. Weir, Renewable Energy Resources, Taylor and Francis (special Indian edition) 2006
2. V.V. N. Kishore (Editor), Renewable Energy Engineering and Technology: Principles and Practice, TERI Publications
3. Handbook of downdraft gasifier-engine systems, T.B. Reed, SERI, USA
4. Prabir Basu, "Biomass gasification and pyrolysis", Academic Press, Elsevier, 2010
5. Hans P. Blaschek, T. Ezeji, J. Scheffran, Biofuels from agricultural wastes and byproducts, Wiley- Blackwell, 2010
6. L.L. Feris, Wind Energy Conversion Systems, Prentice Hall, 1990.
7. D.A. Spera, Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press.
8. Gilbert M. Masters, Renewable and efficient electric power systems, Prentice-Hall
9. S. C. Capareda: Introduction to Biomass Energy Conversions; CRC Press, 2013

## Institute Level Optional Courses (ILOC)

| Semester I       |                                      |           |
|------------------|--------------------------------------|-----------|
| Course Code      | Course Name                          | Credits   |
| <b>ESMIE1011</b> | <b>Product Life Cycle Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

### Outcomes: Learner will be able to...

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

| Module    | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Hrs.      |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>  | <b>Introduction to Product Lifecycle Management (PLM):</b> Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications<br><b>PLM Strategies:</b> Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM | <b>04</b> |
| <b>II</b> | <b>Product Design:</b> Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of                                                                                                                                                                                                                                                                                                                   | <b>06</b> |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process |           |
| <b>III</b> | <b>Product Data Management (PDM):</b> Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation                                                                                                                                                                                                                                                                                                                            | <b>07</b> |
| <b>IV</b>  | <b>Virtual Product Development Tools:</b> For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies                                                                                                                                                                                                                                                                            | <b>07</b> |
| <b>V</b>   | <b>Integration of Environmental Aspects in Product Design:</b> Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design                                                                                                                                                                            | <b>06</b> |
| <b>VI</b>  | <b>Life Cycle Assessment and Life Cycle Cost Analysis:</b> Properties, and Framework of CA, Phases of LCA in ISO Standards, Fields of Application and Limitations of Lifecycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis                                                                                                                                                                                                                     | <b>06</b> |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### **REFERENCES:**

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

## Institute Level Optional Courses (ILOC)

| Semester I       |                                |           |
|------------------|--------------------------------|-----------|
| Course Code      | Course Name                    | Credits   |
| <b>ESMIE1012</b> | <b>Reliability Engineering</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- |       |

### Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

### Outcomes: Learner will be able to...

1. Apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                        | Hrs       |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Probability theory:</b> Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.<br><b>Probability Distributions:</b> Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.<br><b>Measures of Dispersion:</b> Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.                              | <b>08</b> |
| <b>II</b>  | <b>Reliability Concepts:</b> Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.<br><b>Failure Data Analysis:</b> Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.<br><b>Reliability Hazard Models:</b> Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis. | <b>08</b> |
| <b>III</b> | <b>System Reliability:</b> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.                                                                                                                                                                                                                                                                                                                          | <b>05</b> |



|           |                                                                                                                                                                                                                                                                                               |           |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>IV</b> | <b>ReliabilityImprovement:</b> RedundancyTechniques:Elementredundancy,Unitredundancy,Standbyredundancies. Markov analysis.SystemReliability Analysis–Enumerationmethod,Cut-setmethod,SuccessPathmethod,Decompositionmethod.                                                                   | <b>08</b> |
| <b>V</b>  | <b>MaintainabilityandAvailability:</b> Systemdowntime,DesignforMaintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, PartsstandardizationandInterchangeability,ModularizationandAccessibility,RepairVsReplacement.Availability–qualitativeaspects. | <b>05</b> |
| <b>VI</b> | <b>FailureMode,EffectsandCriticalityAnalysis:</b> Failuremodeeffectsanalysis,severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols,developmentoffunctionalreliabilityblockdiagram,FaulttreeanalysisandEventtreeAnalysis                                       | <b>05</b> |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part(b) will be from any module other than module 3)
4. Only Four question need to be solved.

#### **REFERENCES:**

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

## Institute Level Optional Courses (ILOC)

| Semester I       |                                    |           |
|------------------|------------------------------------|-----------|
| Course Code      | Course Name                        | Credits   |
| <b>ESMIE1013</b> | <b>ManagementInformationSystem</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

### Outcomes: Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

| Module     | Detailed Contents                                                                                                                                                                                                      | Hrs.      |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.                      | <b>04</b> |
| <b>II</b>  | Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results | <b>06</b> |
| <b>III</b> | Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls                                                                                                                                  | <b>07</b> |
| <b>IV</b>  | Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.                                                        | <b>07</b> |
| <b>V</b>   | Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.                                                                                                                           | <b>06</b> |

|    |                                                                                                                                                                                                                                                   |    |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| VI | Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development lifecycle models. | 06 |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six questions
2. All questions carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### **REFERENCES:**

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10<sup>th</sup> Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

## Institute Level Optional Courses (ILOC)

| Semester I       |                              |           |
|------------------|------------------------------|-----------|
| Course Code      | Course Name                  | Credits   |
| <b>ESMIE1014</b> | <b>Design of Experiments</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

### Outcomes: Learner will be able to...

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                     | Hrs.      |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Introduction</b><br>1.1 Strategy of Experimentation<br>1.2 Typical Applications of Experimental Design<br>1.3 Guidelines for Designing Experiments<br>1.4 Response Surface Methodology                                                                                                                                                             | <b>04</b> |
| <b>II</b>  | <b>Fitting Regression Models</b><br>2.1 Linear Regression Models<br>2.2 Estimation of the Parameters in Linear Regression Models<br>2.3 Hypothesis Testing in Multiple Regression<br>2.4 Confidence Intervals in Multiple Regression<br>2.5 Prediction of new response observation<br>2.6 Regression model diagnostics<br>2.7 Testing for lack of fit | <b>06</b> |
| <b>III</b> | <b>Two-Level Factorial Designs and Analysis</b><br>3.1 The $2_2$ Design<br>3.2 The $2_3$ Design<br>3.3 The General $2_k$ Design<br>3.4 A Single Replicate of the $2_k$ Design<br>3.5 The Addition of Center Points to the $2_k$ Design,                                                                                                               | <b>07</b> |

|           |                                                                                                                                                                                                                                                                                                                                          |           |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|           | 3.6 Blocking in the $2^k$ Factorial Design<br>3.7 Split-Plot Designs                                                                                                                                                                                                                                                                     |           |
| <b>IV</b> | <b>Two-Level Fractional Factorial Designs and Analysis</b><br>4.1 The One-Half Fraction of the $2^k$ Design<br>4.2 The One-Quarter Fraction of the $2^k$ Design<br>4.3 The General $2^{k-p}$ Fractional Factorial Design<br>4.4 Resolution III Designs<br>4.5 Resolution IV and V Designs<br>4.6 Fractional Factorial Split-Plot Designs | <b>07</b> |
| <b>V</b>  | <b>Conducting Tests</b><br>5.1 Testing Logistics<br>5.2 Statistical aspects of conducting tests<br>5.3 Characteristics of good and bad data sets<br>5.4 Example experiments<br>5.5 Attribute Vs Variable data sets                                                                                                                       | <b>06</b> |
| <b>VI</b> | <b>Taguchi Approach</b><br>6.1 Crossed Array Designs and Signal-to-Noise Ratios<br>6.2 Analysis Methods<br>6.3 Robust design examples                                                                                                                                                                                                    | <b>06</b> |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### **REFERENCES:**

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup> edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2<sup>nd</sup> Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

## Institute Level Optional Courses (ILOC)

| Semester I       |                            |           |
|------------------|----------------------------|-----------|
| Course Code      | Course Name                | Credits   |
| <b>ESMIE1015</b> | <b>Operations Research</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

### Outcomes: Learner will be able to...

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

| Module   | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Hrs.      |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b> | <p><b>Introduction to Operations Research:</b> Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p><b>Linear Programming:</b> Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method,</p> <p><b>Duality,</b> Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p><b>Transportation Problem:</b> Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.</p> <p><b>Assignment Problem:</b> Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem</p> | <b>12</b> |

|            |                                                                                                                                                                                                                                                                              |           |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|            | <b>Integer Programming Problem:</b> Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.                                                                             |           |
| <b>II</b>  | <b>Queuing models:</b> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population                                                                                      | <b>04</b> |
| <b>III</b> | <b>Simulation:</b> Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation        | <b>04</b> |
| <b>IV</b>  | <b>Dynamic programming.</b> Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.                                       | <b>04</b> |
| <b>V</b>   | <b>Game Theory.</b> Competitive games, rectangular game, saddle point, minimax(maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games. | <b>04</b> |
| <b>VI</b>  | <b>Inventory Models:</b> Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,                                                                                                                                                      | <b>04</b> |

### Assessment:

#### Internal:

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

#### End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Wiley and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Lieberman, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

## Institute Level Optional Courses (ILOC)

| Semester I       |                                |           |
|------------------|--------------------------------|-----------|
| Course Code      | Course Name                    | Credits   |
| <b>ESMIE1016</b> | <b>Cyber Security and Laws</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognize Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

### Outcomes: Learner will be able to...

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Hrs.      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Introduction to Cybercrime:</b> Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>04</b> |
| <b>II</b>  | <b>Cyber offenses &amp; Cybercrime:</b> How criminals plan the attacks, Social Engg, Cyberstalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Fraud in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops | <b>08</b> |
| <b>III</b> | <b>Tools and Methods Used in Cyberline</b><br>Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)                                                                                                                                                                                                                                                                                                                                                                                                              | <b>06</b> |



|           |                                                                                                                                                                                                                                                                                                                                                                                          |           |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>IV</b> | <b>The Concept of Cyberspace</b><br>E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law | <b>06</b> |
| <b>V</b>  | <b>Indian IT Act.</b><br>Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments                                                                                                                                                                                                                                   | <b>04</b> |
| <b>VI</b> | <b>Information Security Standard compliances</b><br>SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.                                                                                                                                                                                                                                                                                             | <b>04</b> |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### **REFERENCES:**

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

## Institute Level Optional Courses (ILOC)

| Semester I       |                                                    |           |
|------------------|----------------------------------------------------|-----------|
| Course Code      | Course Name                                        | Credits   |
| <b>ESMIE1017</b> | <b>Disaster Management and Mitigation Measures</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

### Outcomes: Learner will be able to...

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

| Module    | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Hrs.      |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>  | <b>Introduction</b><br>Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.                                                                                                                                                                                                                                                                                          | <b>04</b> |
| <b>II</b> | <b>Natural Disaster and Manmade disasters:</b><br>2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion<br>2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters. | <b>08</b> |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>III</b> | <b>Disaster Management, Policy and Administration</b><br>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.<br>3.2 Policy and administration:<br>Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.                                                                                                                                | <b>06</b> |
| <b>IV</b>  | <b>Institutional Framework for Disaster Management in India:</b><br>4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management(NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.<br>4.2 Use of Internet and software's for effective disaster management. Applications of GIS,Remote sensing and GPS in this regard. | <b>06</b> |
| <b>V</b>   | <b>Financing Relief Measures:</b><br>5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.<br>5.2 International relief aid agencies and their role in extreme events.                                                                                                                                                                                        | <b>07</b> |
| <b>VI</b>  | <b>Preventive and Mitigation Measures:</b><br>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general<br>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication<br>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.<br>6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.                                                               | <b>05</b> |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (**on minimum Two Modules**) and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

**REFERENCES:**

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
  2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
  3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
  4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
  5. 'Disaster management & rehabilitation' by RajdeepDasgupta, Mittal Publications, New Delhi.
  6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
  7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.
- (Learners are expected to refer reports published at national and International level and updated informationavailable on authentic web sites)

## Institute Level Optional Courses (ILOC)

| Semester I       |                                    |           |
|------------------|------------------------------------|-----------|
| Course Code      | Course Name                        | Credits   |
| <b>ESMIE1018</b> | <b>Energy Audit and Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

### Outcomes: Learner will be able to...

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

| Module    | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Hrs.      |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>  | <b>Energy Scenario:</b><br>Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance                                                                                                                                                                                                                                                                                 | <b>04</b> |
| <b>II</b> | <b>Energy Audit Principles:</b><br>Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring&targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment(ROI), Internal rate of return (IRR) | <b>08</b> |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| III | <b>Energy Management and Energy Conservation in Electrical System:</b><br>Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment and appliances, star ratings.<br><b>Energy efficiency measures in lighting system, Lighting control:</b> Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.                           | 06 |
| IV  | <b>Energy Management and Energy Conservation in Thermal Systems:</b><br>Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities. | 06 |
| V   | <b>Energy Performance Assessment:</b><br>On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.                                                                                                                                                                                                                                                                                                               | 07 |
| VI  | <b>Energy conservation in Buildings:</b><br>Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources                                                                                                                                                                                                                                                                                                                                                                                             | 05 |

### Assessment:

#### Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

### REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. [www.energymanagertraining.com](http://www.energymanagertraining.com)
9. [www.bee-india.nic.in](http://www.bee-india.nic.in)

| Semester I     |                                                   |           |
|----------------|---------------------------------------------------|-----------|
| Course Code    | Course Name                                       | Credits   |
| <b>ESML101</b> | <b>Energy System Modelling and Simulation Lab</b> | <b>01</b> |

| Teaching Scheme |           |          |                  |           |          |       |
|-----------------|-----------|----------|------------------|-----------|----------|-------|
| Contact Hours   |           |          | Credits Assigned |           |          |       |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| --              | 02        | --       | --               | 01        | --       | 01    |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| --                  | --    | --      | --           | --                       | 25                       | 25 | -- | 50    |

**Simulation study using mathematical simulation software (or any programming language)**

1. Study of Different Modeling Techniques practiced in Power Plant Engineering
2. Simulation study using Mathematical Simulation Software (or any programming language) on any two conventional power plants
3. Simulation study of any two non-conventional power plant
4. Visit to Power Plant Control Room to Understand Automated Control System in Power Plant and prepare visit report.

**Assessment:**

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners

| Semester I       |                         |           |
|------------------|-------------------------|-----------|
| Course Code      | Course Name             | Credits   |
| <b>ESMSBL101</b> | <b>Energy Audit Lab</b> | <b>02</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| --              | <b>04</b> | --       | --               | <b>02</b> | --       | <b>02</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| --                  | --    | --      |              |                          |                          |    |    |       |
| --                  | --    | --      | --           | --                       | 50                       | 50 | -- | 100   |

The following experiments are performed and readings must be entered in the energy audit report format.

1. Finding energy saving potential from specific power consumption and EER of Air conditioner.
2. Illuminance calculation and lighting design for an interior.
3. Centrifugal Pump efficiency calculation and ENCON opportunities.
4. 3- $\Phi$ /1-  $\Phi$  motor loading calculation and ENCON opportunities.
5. Fan/Blower efficiency calculation and ENCON opportunities.
6. Performance testing of Air compressor and ENCON opportunities.
7. Leakage testing of Air compressor and ENCON opportunities.
8. Study of an Electricity bill and ENCON opportunities.

### Assessment:

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners



| Semester II    |                                                  |           |
|----------------|--------------------------------------------------|-----------|
| Course Code    | Course Name                                      | Credits   |
| <b>ESMC201</b> | <b>Advances in Energy Management &amp; Audit</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |       |
|-----------------|-----------|----------|------------------|-----------|----------|-------|
| Contact Hours   |           |          | Credits Assigned |           |          |       |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| 03              | --        | --       | 03               | --        | --       | 03    |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To collect and analyze the energy audit data effectively
2. To understand the mechanism of PAT cycle.
3. To become certified energy manager and auditor.

### Outcomes: Learner will be able to...

1. Understand detailed energy auditing procedure and distinguish between energy auditing stages.
2. Monitor and setting target of energy consumption.
3. Know the framework of PAT cycle and understand M&V audit
4. Carry out commercial energy audits.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                     | Hrs. |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>I</b>   | <b>Energy Management and Audit Methodology</b><br>Energy Audit and Management, Energy audit Inquiry Generation, Walk in Audit, Preliminary Energy audit, Detailed Energy Audit, Targeted Energy Audit, Financial feasibility and Economic Approach, Energy Audit Report Format, Case study.           | 06   |
| <b>II</b>  | <b>Categories of Energy Manager and Auditor</b><br>Energy Manager (EM), Energy Auditor (EA) certification in India, Duties and responsibilities of EM and EA, Accredited Energy Auditor (AEA), Empaneled AEA, BEE (The manner and intervals of time for conduct of energy audit) Regulations, 2008.   | 08   |
| <b>III</b> | <b>Energy Monitoring and Targeting (EMT)</b><br>Definition of EMT, Elements of EMT system, Decision Making of EMT, Data information sources, Data analysis, Statistical representation of Energy consumption and Production, Least square method, Correlation & regression, CUSUM technique.          | 10   |
| <b>IV</b>  | <b>Perform, Achieve &amp; Trade (PAT) Cycle</b><br>Brief description of PAT (Perform, Achieve & Trade) Cycle, Designated Consumer, Institutional framework for PAT, Role of each entity in PAT cycle, Activities and Responsibilities for PAT cycle, EScerts Issuance flow chart, Trading of EScerts. | 08   |

|           |                                                                                                                                                                                                                                                                                                                                                                            |    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>V</b>  | <b>Energy Audits in PAT cycle</b><br>Baseline Energy Audit, Definition of (Monitoring & Verification) M & V, Team formation for M&V audit, Appointment and Role of Empanelled AEA, Documents required for M & V, Gate to Gate Diagram for various industries, Verification process, Concept of Normalization in PAT, Need for Mandatory Energy Audit.                      | 10 |
| <b>VI</b> | <b>Energy Audit in Commercial Sectors</b><br>Need of energy auditing in commercial sectors, energy audit in corporate buildings, educational institutes, Hospitals, Banks, Resorts, government buildings, Estimation of building load, steady state method, network method, numerical method, correlations, Calculation of energy saving potential by ENCON opportunities. | 10 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

#### **References:**

1. BEE Reference books: no.1/2/3/4
2. <http://beenet.gov.in>
3. PAT booklet, BEE India
4. Handbooks of Energy Audits and Management, edited by A. K Tyagi, TERI, India.
5. Abstract, Methodology for Monitoring & Verification of Specific Energy Consumption performance of Designated Consumers © Bureau of Energy Efficiency, Government of India, March 2015.
6. Amlan Chakrabarti, Energy engineering and management, PHI Learning, New Delhi 2012
7. Shaligram Pokharel, Energy Analysis for Planning and Policy, CRC Press, 2014

| Semester II    |                                                |           |
|----------------|------------------------------------------------|-----------|
| Course Code    | Course Name                                    | Credits   |
| <b>ESMC202</b> | <b>Energy Efficiency in Electrical Systems</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To learn electrical and power systems.
2. To understand working principle of electrically assisted systems.
3. To identify saving potential in electrically assisted systems.

### Outcomes: Learner will be able to...

1. Calculate losses in electrical and power systems and improve its energy efficiency.
2. Determine ENCON opportunities in electrical motor systems.
3. Determine ENCON opportunities in fluids handling systems.
4. Determine ENCON opportunities in lighting systems.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                       | Hrs. |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>I</b>   | <b>Electrical and Power System</b><br>Electric power supply, Transmission and Distribution Losses, Electricity Billing, Electrical Load Management, Power Factor Improvement, Transformers, Harmonics, Analysis of Electrical Power Systems, Maximum demand controllers. Automatic power factor controllers, Energy efficient transformers, Case study. | 08   |
| <b>II</b>  | <b>Electrical Motors</b><br>Types, Characteristics & Efficiency of Motors, Selection, Factors Affecting Energy Efficiency, Rewinding, Motor Load Survey Methodology, Energy efficient motors, soft starters with energy saver, Variable speed drives, ENCON opportunities, Case study.                                                                  | 08   |
| <b>III</b> | <b>Fans, Blowers and Compressors</b><br>Difference between Fans, Blowers and Compressors, types, Flow control methods in fan, <b>Fan performance evaluation</b> , Types of compressors, <b>Compressor Performance Evaluation</b> , Compressed Air Systems & their efficient operation, Compressor Capacity Assessment, ENCON opportunities, Case study. | 12   |
| <b>IV</b>  | <b>Refrigeration and HVAC system</b><br>Types of refrigeration system, components, Chilling plant, Selection and performance assessment of refrigeration plants, Factors affecting energy efficiency of refrigeration plants, ENCON opportunities, Case study.                                                                                          | 08   |

|    |                                                                                                                                                                                                                                                                                                                                                       |    |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| V  | <b>Centrifugal Pumps &amp; Cooling Towers</b><br>Pump types, System & pump characteristics, <b>Pump Performance evaluation</b> , Energy efficient pumping system operation, ENCON opportunities by Flow control methods in pumps, Use & types of cooling tower, Performance evaluation, Energy efficient operation, Flow control methods, Case study. | 10 |
| VI | <b>Lighting Systems</b><br>Terms in Lighting System, Lamp Types & features, Recommended luminance Levels, Lighting Design calculations for Interiors, Lighting System Energy Efficiency Study Methodology, Energy Efficient Replacement Options, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Case Study.               | 06 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

#### **References:**

1. Energy efficiency in electrical utilities, Book 3, Bureau of Energy Efficiency India.
2. Energy performance assessment for equipment & utility systems, Book 4, Bureau of Energy Efficiency India
3. Electrical energy conservation modules of AIP-NPC, Chennai
4. PCRA Publications on Compressed Air System
5. Technology Menu for Energy Efficiency(NPC)
6. ASHRAE Handbook
7. British Pump Manufacturers' Association Catalogue
8. Energy Management Supply & Conservation, Butterworth Heinemann, Dr. CliveBeggs.

## Program Elective 1

| Semester II      |                                                   |           |
|------------------|---------------------------------------------------|-----------|
| Course Code      | Course Name                                       | Credits   |
| <b>ESMPE2011</b> | <b>Renewable &amp; Sustainable Energy Systems</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To understand the concept of sustainable development.
2. To know the economics of renewable energy and financing options.
3. To determine role of renewable energy in upcoming projects.

**Outcomes:** Learner will be able to...

1. Know sustainability initiatives for reducing energy impacts on environment.
2. Understand the role of renewable energy in climate change.
3. Determine the efficient solar and wind energy technology.
4. Know the current trends in sustainable and renewable energy.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                  | Hrs. |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>I</b>   | <b>Sustainable Energy &amp; Environment</b><br>Sustainable Development, Energy technologies promoting sustainability, Environmental impacts, Economic and social considerations, Financing mechanisms, Carbon credits, clean development mechanisms, Climate change, COP21.                                                                                                                                                                        | 08   |
| <b>II</b>  | <b>Renewable Energy</b><br>Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy.                                                                                                                                                                                                                                                                      | 08   |
| <b>III</b> | <b>Solar Energy Technology</b><br>Solar thermal power plants (Concentrators, solar chimney etc.), Solar thermal conversion devices, Economics and social considerations, Design considerations of component selection, CSP (Concentrated Solar Power) advanced materials.<br>Solar photovoltaic power plants, photovoltaic technology, Design of a photovoltaic system, economics and costing, Application as a distributed power supply strategy. | 10   |

|           |                                                                                                                                                                                                                                                                                                                        |    |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>IV</b> | <b>Wind Power Technology</b><br>Wind energy potential measurement, wind mill component design, economics and demand side management, energy wheeling, and energy banking concepts.                                                                                                                                     | 06 |
| <b>V</b>  | <b>Biogas Energy</b><br>Aerobic and anaerobic bio-conversion processes, microbial reactions purification, properties of biogas. Storage and enrichment, Biogas energy economics.                                                                                                                                       | 06 |
| <b>VI</b> | <b>Current Trends in Renewable &amp; Sustainable Energy</b><br>Fuel cell-based power plants, tidal and wave energy plant design, OTEC power plants. Geothermal energy: hot springs and steam ejection site selection, Renewable energy Financing criteria, Net Metering, Solar cities, Role of energy in smart cities. | 08 |

### **Assessment:**

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **References:**

1. General Aspects of Energy Management and Energy Audit, Book 1, Bureau of Energy Efficiency India.
2. G. N. Tiwari and M. K. Ghosal, Renewable Energy Resources: Basic Principles and Applications, Alpha Science International Ltd.,2005.
3. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 3rd edition,2006.
4. G. Boyle, Renewable Energy: Power for a Sustainable World, Oxford University Press, 2006.
5. T.C.Kandpal and H.P.Garg., Financial Evaluation of Renewable Energy Technologies, Macmillan India Ltd.,2003.
6. J. Twidell and T. Weir, Renewable Energy Resources, Taylor & Francis,2007.
7. G. N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications, Narosa Publishing House,2010.
8. Harry Campbell and Richard Broron, Benefit- Cost Analysis, Cambridge University Press, 2003.
9. Chan S. Park, Contemporary Engineering Economics, Prentice Hall Inc.,2002.
10. Gerald J. Thuesen and W.J. Fabrycky, Engineering Economy (ninth edition), Prentice Hall Inc.,2001.

## Program Elective 1

| Semester II      |                               |           |
|------------------|-------------------------------|-----------|
| Course Code      | Course Name                   | Credits   |
| <b>ESMPE2012</b> | <b>Energy Storage Systems</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |       |
|-----------------|-----------|----------|------------------|-----------|----------|-------|
| Contact Hours   |           |          | Credits Assigned |           |          |       |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| 03              | --        | --       | 03               | --        | --       | 03    |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To understand the working principle of energy storage systems.
2. To identify and select the efficient energy storage systems.
3. To find suitable application of storage system.

**Outcomes:** Learner will be able to...

1. Distinguish between different modes of energy storage.
2. Know the working principle and selection of Energy Storage System.
3. Understand the concept of Sensible and Latent Heat Thermal Energy Storage.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Hrs. |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>I</b>   | <b>Energy Storage</b><br>Need of energy storage; Different modes of Energy Storage.<br>Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage | 12   |
| <b>II</b>  | <b>Electrochemical Energy Storage Systems</b><br>Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon Nano-tubes in electrodes.                                                                                                                                                                                                                            | 08   |
| <b>III</b> | <b>Magnetic and Electric Energy Storage Systems</b><br>Superconducting Magnet Energy Storage (SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated Carbon and carbon Nano-tube(CNT).                                                                                                                       | 09   |
| <b>IV</b>  | <b>Sensible Heat Storage</b><br>SHS mediums; Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; Earth storage; Energy storage in aquifers; Heat storage in SHS systems; Aquifers storage.                                                                                                                                                                                                                                                | 08   |

|    |                                                                                                                                                                                                                                                                                                                                             |    |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| V  | <b>Latent Heat Thermal Energy Storage</b><br>Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems; Enthalpy formulation; Numerical heat transfer in melting and freezing process. | 09 |
| VI | <b>Application of Energy Storage</b><br>Food preservation; Waste heat recovery; Solar energy storage; Greenhouse heating; Power plant applications; Drying and heating for process industries.                                                                                                                                              | 06 |

### **Assessment:**

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carryequal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **References:**

1. Thermal Energy Storage Systems& Applications, Ibrahim Dincer, Mark Rosen, John Wiley& Sons2002.
2. Electrochemical Technologies for energy storage & Conversions, Ru-shillu, Leizhang, Wiley Publications,2012
3. Solar Thermal Energy Storage, H P Garg, S C Mulik, A K Bhargava,1985.
4. Advances in Thermal Energy Storage Systems: Methods and Applications, Woodhead Publishing Series inenergy
5. Solar Collectors, Energy Storage and Materials (Solar Heat Technologies), Francis de Winter, The MIT Press,1991.



## Program Elective 1

| Semester II      |                                              |           |
|------------------|----------------------------------------------|-----------|
| Course Code      | Course Name                                  | Credits   |
| <b>ESMPE2013</b> | <b>Fuels Combustion and Emission Control</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To give an idea about types of fuels, origin, reserves and their processing.
2. To define the combustion and conversion process of fuels.
3. To analyze the impact of incomplete combustion, emission on environment.

**Outcomes:** Learner will be able to...

1. Distinguish between conventional, non-conventional and nuclear fuels.
2. Understand the types and production process of fuels.
3. Determine the requirements for complete combustion process.
4. Analyze the effects of emission control
- 5.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                      | Hrs. |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>I</b>   | <b>Introduction to Fuels</b><br>Types of fuels, commercial and non-commercial fuels, Principle fuels for energy conversion: Fossil fuels, Nuclear fuels, RDF, Bio-fuels                                                                                                                                                                                                | 05   |
| <b>II</b>  | <b>Solid Fuels</b><br>Different types of solid fuels, Family of coal, origin of coal, composition of coal, analysis and properties of coal, action of heat on coal, oxidation of coal, hydrogenation of coal, classification of Indian coal, Storage of coal, carbonization, gasification and liquefaction and pulverization of solid fuels.                           | 09   |
| <b>III</b> | <b>Liquid Fuels</b><br>Introduction to Petroleum, origin of petroleum, petroleum production, composition and classification, processing of petroleum, Important petroleum products, properties of petroleum products, liquid fuels from sources other than petroleum, storage and handling of liquid fuels, gasification of liquid fuels, petroleum refining in India. | 09   |
| <b>IV</b>  | <b>Gaseous Fuels</b><br>Classification of gaseous fuels based on mode of occurrence and method of production, cleaning and purification of gaseous fuels. Hydrogen as energy carrier                                                                                                                                                                                   | 08   |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                             |    |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| V  | <b>Combustion of Fuels</b><br>Combustion stoichiometry, Nature of combustion process, types of combustion process, Mechanism of combustion reaction, Spontaneous ignition temperature, velocity of flame propagation, limits of inflammability, flame structure, stability and diffusion of flames.<br>Kinetics of liquid and solid fuel combustion.<br>Combustion appliances: Oil and gas burners, coal burning equipment. | 15 |
| VI | <b>Emission control</b><br>Introduction, atmosphere, Emission control methods. Quantification of emissions.                                                                                                                                                                                                                                                                                                                 | 06 |

### **Assessment:**

#### Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carries equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved

### **References:**

1. D P Mishra, Fundamentals of Combustion, PHI Publications.
2. S P Sharma, Fuels and combustion, Tata McGraw Hill Publications, 1984.
3. Samir Sarkar, Fuels and combustion, Universities Press (India) Pvt Ltd, Third Edition 2009.
4. Stephen Turns, an Introduction to Combustion: Concepts and Applications, McGraw Hill Publications.
5. K K Kuo, Principles of combustion 2nd Edition, John Wiley & Sons, New Jersey, 2005
6. Gupta R B, Boca Raton, Hydrogen fuel: Production, transport and storage, CRC Press, 2008
7. Combustion Engineering and Fuel Technology, Oxford & IBH Publishing Company A. K. Shaha.
8. S. Sarkar, Fuels and Combustion, Orient Longman, 2nd edition, 1990.
9. F. Peter, Fuels and Fuel Technology, A. Wheatan & Co. Ltd., 1st edition, 1965.

## Program Elective 2

| Semester II      |                                                   |           |
|------------------|---------------------------------------------------|-----------|
| Course Code      | Course Name                                       | Credits   |
| <b>ESMPE2021</b> | <b>Energy Measurement and Control Instruments</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To identify and select the correct instruments for related parameters
2. To learn the operation of automatic control systems.
3. To train about the handling and maintenance of energy measurement instruments

**Outcomes:** Learner will be able to...

1. To understand the basic measurement concepts and principles.
2. To learn the methods of measuring the process parameters.
3. To understand techniques of measuring energy system parameters.
4. To learn selection of proper instrument for concerned measurement.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                        | Hrs. |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>I</b>   | <b>Measurement Concepts</b><br>Introduction to measurements for scientific and engineering application need and goal. Broad category of methods for measuring field and derived quantities. Principles of measurement, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data | 10   |
| <b>II</b>  | <b>Process Parameter Measurement</b><br>Measurement of field quantities, measurement of force, pressure, temperature, flow rate, velocity, humidity, noise, vibration, measurement by probe and non-destructive techniques, Name, Make and Specification of Instruments.                                                                 | 09   |
| <b>III</b> | Measurement of derived quantities, torque, power, thermo physical properties, radiation and surface properties, Name, Make and Specification of Instruments.                                                                                                                                                                             | 09   |
| <b>IV</b>  | <b>Automatic Control Systems</b><br>Control Room Equipment, PLCs and other logic devices, Analytical instrumentation,                                                                                                                                                                                                                    | 10   |

|    |                                                                                                                                                                                                                                                                      |    |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| V  | <b>Instrument Selection and Commissioning</b><br>General considerations, Control valve selection and sizing, Regulators and final control elements, Limits, Margins and their Relevance to Instrumentation and control, Control Centers, Fire and Safety Instruments | 10 |
| VI | <b>Instruments in Energy Auditing</b><br>Need of measurement, electrical, mechanical, thermal, chemical, fluid measurement, types of instruments, handling of instruments on site and off site, care of instruments, calibration.                                    | 04 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved

### **References:**

1. Bela G Liptak, Instrument Engineers' Handbook, Vol I, II, III, 4th Edition, CRCPress
2. Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
3. Bolton W, Mechatronics-Electronics Control Systems in Mechanical and ElectricalEngg.
4. Helfrick A.D. and Cooper W.D. Modern Electronic Instrumentation and Measurement Technique.
5. Johnson C.D., Process ControlInstrumentation
6. J.P.Holman: Experimental Methods For Engineers, McGraw Hill International Edition, SeventhEdition
7. Bureau of energy efficiency book No1.

## Program Elective 2

| Semester II      |                                                  |           |
|------------------|--------------------------------------------------|-----------|
| Course Code      | Course Name                                      | Credits   |
| <b>ESMPE2022</b> | <b>Energy Systems &amp; Environmental Impact</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives

1. To understand impact of energy systems on environment.
2. To know the pollution control techniques.
3. To recite energy and environment policies.

**Outcomes:** Learner will be able to...

1. Determine the impact of pollutants on atmosphere.
2. Propose the pollution control systems in energy systems.
3. Understand International and Indian environment policies.
4. Calculate the effect of energy efficiency on global climate change.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Hrs. |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>I</b>   | <b>Effect of Energy Systems on Environment</b><br>Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SO <sub>x</sub> , NO <sub>x</sub> , SPM in air, Depletion of ozone layer, global warming, Physiological and health problems due to energy plants. Methods of Environmental Impact Assessment.                                                                                                                                                                                  | 08   |
| <b>II</b>  | <b>Water, Air and Land Pollution</b><br>Sources of Pollution in thermal power plant, Water, air, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control, Water pollution in thermal power plant, physical and chemical methods of pollution control, Measurement and effects of land pollution, Pollution control systems. Hydrothermal plant environmental assessment, Nuclear power plants and environmental pollution, pollution control measures. | 10   |
| <b>III</b> | <b>Pollution due to Automobile &amp; Utilities</b><br>Pollution due to automobile and utilities, Methods to Control emission from Vehicle, Boilers & Furnaces., International Standards for Quality of air and norms for exhaust gases. Software advantage & disadvantage in automobile pollution inspection.                                                                                                                                                                                                                                | 08   |

|           |                                                                                                                                                                                                                                                                                                                                              |    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>IV</b> | <b>Energy Recovery from Industrial and Urban Waste</b><br>Industrial waste, Waste and effluent treatment plants, Industrial, domestic and solid waste as a source of energy, Water treatment plant in housing societies.                                                                                                                     | 08 |
| <b>V</b>  | <b>Environmental and Pollution Control Policies</b><br>United Nations Framework Convention on Climate Change (UNFCCC), IPCC, Conference of Parties (COP), COP 21 Accord, Clean Development Mechanism (CDM), Prototype Carbon Funds (PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project in India. | 08 |
| <b>VI</b> | <b>Energy Efficiency and Global Climate Change</b><br>Global Environmental Issues, Acid rain, Loss of Biodiversity, Ozone layer depletion, Global Warming Potential (GWP), Global warming & Climate change Impact, India's Green House Gases Emission.                                                                                       | 10 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved

#### **References:**

1. Management of Energy Environment Systems W.K.Foell (John Wiley and Sons).
2. Energy Management and Control Systems M.C.Macedo Jr. (John Wiley and Sons)
3. Environmental Impact Analysis Handbook J.G. Rau, D.C. Wood (McGraw Hill)
4. Energy & Environment – J.M. Fowler,(McGraw Hill)
5. Thermal Environmental Engineering, J.L. Threlkeld, Prentice Hall, 1970.
6. BEE Reference book:no.1
7. Global Warming: J Houghton, Cambridge University Press, New York, 1997.
8. CDM Country Guide for INDIA: Institute for Global Environmental Strategies (Ed), Ministry of the Environment, Japan,2005.
9. Global Environmental Issues: F Harris (Ed), John Wiley, hichester2004.
10. <http://beeindia.gov.in>

| Semester II      |                                                     |           |
|------------------|-----------------------------------------------------|-----------|
| Course Code      | Course Name                                         | Credits   |
| <b>ESMPE2023</b> | <b>Materials And Devices for Energy Application</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

#### Course Outcomes:

After successful completion of the course the student will be able to

1. Understand device fabrication technologies in the semiconductor industries.
2. Understand the various characterization techniques.
3. Understand the solar cell physics and various methods to improve the efficiency of solar cell.
4. Understand various applications such as fuel cell, battery and carbon nanotubes and its applications.

| Module No  | Detailed Contents                                                                                                                                                                                                                                                                                                                                         | Hrs |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>I</b>   | <b>Device fabrication technologies</b> Diffusion, oxidation, photolithography, sputtering, physical vapor deposition, chemical vapor deposition (CVD), plasma enhanced CVD (PECVD), hot wire CVD (HWCVD), etc.                                                                                                                                            | 12  |
| <b>II</b>  | <b>Introduction to material characterization</b><br>Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X-ray diffraction (XRD), Raman spectroscopy, Atomic force microscopy (AFM), Spectral response of solar cells, quantum efficiency analysis, dark conductivity, I-V characterization                                        | 06  |
| <b>III</b> | <b>Basics of solar cells</b><br>High efficiency solar cells, PERL Si solar cell, III-V high efficiency solar cells, GaAs solar cells, tandem and multi-junction solar cells, solar PV concentrator cells and systems, III-V, II-VI thin-film solar cells (GaAs, Cu(In,Ga)Se <sub>2</sub> , CdTe ) Nano-, micro- and poly-crystalline Si for solar cells,. | 06  |

|           |                                                                                                                                                                                                                                                                                                                             |    |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>IV</b> | <b>Advanced Solar Cells</b><br>Amorphous silicon thin-film (and/or flexible) technologies, multi-junction (tandem) solar cells, stacked solar cells. Conjugated polymers, organic/plastic/flexible solar cells, polymer composites for solar cells, device fabrication and characterization. Standalone systems, Micro Grid | 06 |
| <b>V</b>  | <b>Materials and devices for energy storage</b><br>Batteries, Carbon Nano-Tubes (CNT), fabrication of CNTs, CNTs for hydrogen storage, CNT-polymer composites, hydrogen storage in metal hydrides; ultra- capacitors etc. Polymer membranes for fuel cells, PEM fuel cell, Acid/alkaline fuel cells.                        | 09 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

5. Question paper will comprise of total six question
6. All question carry equal marks
7. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
8. Only Four questions need to be solved

### **References:**

1. Solar cells: Operating principles, technology and system applications, by Martin A. Green, Prentice-Hall Inc, Englewood Cliffs, NJ, USA,1981.
2. Semiconductors for solar cells, H. J. Moller, Artech House Inc, MA, USA, 1993.Solid State electronic devices, Ben G. Streetman, , Prentice-Hall of India Pvt. Ltd., New delhi1995.
3. Carbon nanotubes and related structures: New material for twenty-first century, P. J. F.Harris, Cambridge University Press,1999.
4. Thin-film crystalline silicon solar cells: Physics and technology, R.Brendel, Wiley- VCH, Weinheim,2003.
5. Clean electricity from photovoltaics, M. D. Archer, R. Hill, Imperial college press, 2001.



## Institute Level Optional Courses (ILOC)

| Semester II      |                           |           |
|------------------|---------------------------|-----------|
| Course Code      | Course Name               | Credits   |
| <b>ESMIE2011</b> | <b>Project Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

### Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                 | Hrs |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>I</b>   | <b>Project Management Foundation:</b><br>Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI). | 5   |
| <b>II</b>  | <b>Initiating Projects:</b><br>How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.                                 | 6   |
| <b>III</b> | <b>Project Planning and Scheduling:</b><br>Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).                                              | 8   |

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| <b>IV</b> | <b>Planning Projects:</b><br>Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.<br>Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks                                                                                                                                                                      | 6 |
| <b>V</b>  | <b>5.1 Executing Projects:</b><br>Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.<br>Team management, communication and project meetings.<br><b>5.2 Monitoring and Controlling Projects:</b><br>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.<br><b>5.3 Project Contracting</b><br>Project procurement management, contracting and outsourcing,                              | 8 |
| <b>VI</b> | <b>6.1 Project Leadership and Ethics:</b><br>Introduction to project leadership, ethics in projects.<br>Multicultural and virtual projects.<br><b>6.2 Closing the Project:</b><br>Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study. | 6 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

### **References:**

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7<sup>th</sup> Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5<sup>th</sup> Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9<sup>th</sup> Ed.

## Institute Level Optional Courses (ILOC)

| Semester II      |                           |           |
|------------------|---------------------------|-----------|
| Course Code      | Course Name               | Credits   |
| <b>ESMIE2012</b> | <b>Finance Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- |       |

### Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

### Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

| Module    | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Hrs       |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>  | <b>Overview of Indian Financial System:</b> Characteristics, Components and Functions of Financial System.<br><b>Financial Instruments:</b> Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.<br><b>Financial Markets:</b> Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market<br><b>Financial Institutions:</b> Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges | <b>06</b> |
| <b>II</b> | <b>Concepts of Returns and Risks:</b> Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.<br><b>Time Value of Money:</b> Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.                                                                                                                                                                                         | <b>06</b> |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| III | <b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.<br><b>Financial Ratio Analysis:</b> Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.                                                                                                                                                                     | 09 |
| IV  | <b>Capital Budgeting:</b> Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)<br><b>Working Capital Management:</b> Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities. | 10 |
| V   | <b>Sources of Finance:</b> Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short-Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.<br><b>Capital Structure:</b> Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure                                                                                                                                       | 05 |
| VI  | <b>Dividend Policy:</b> Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach                                                                                                                                                                                                                                                                                                                                                                                                                              | 03 |

### **Assessment:**

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **References:**

1. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11<sup>th</sup> Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

## Institute Level Optional Courses (ILOC)

| Semester II      |                                                    |           |
|------------------|----------------------------------------------------|-----------|
| Course Code      | Course Name                                        | Credits   |
| <b>ESMIE2013</b> | <b>Entrepreneurship Development and Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |         |         |              |                          |                          |    |    |       |
|---------------------|---------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |         |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |         |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2   | Average |              |                          |                          |    |    |       |
| 20                  | 20      | 20      |              |                          |                          |    |    |       |
| 80                  | 03 Hrs. | --      | --           | --                       | 100                      |    |    |       |

### Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

### Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Hrs |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>I</b>   | <b>Overview Of Entrepreneurship:</b> Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership<br>Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship                                                                                                                       | 04  |
| <b>II</b>  | <b>Business Plans And Importance Of Capital To Entrepreneurship:</b> Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur<br><b>Entrepreneurship And Business Development:</b> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations | 09  |
| <b>III</b> | Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises                                                                                                                                                                                                                                                                                                                                                                             | 05  |

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>IV</b> | <b>Indian Environment for Entrepreneurship:</b> key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc | 08 |
| <b>V</b>  | <b>Effective Management of Business:</b> Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing                                                                                                                                                                                   | 08 |
| <b>VI</b> | <b>Achieving Success In The Small Business:</b> Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business<br>Critical Success factors of small business                                                                                                                                                                                                                                                 | 05 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
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4. Only Four questions need to be solved.

### **References:**

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGraw Hill Company
3. Dr T N Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Tax mann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. [www.msme.gov.in](http://www.msme.gov.in)
12. [www.dcmesme.gov.in](http://www.dcmesme.gov.in)
13. [www.msmetraining.gov.in](http://www.msmetraining.gov.in)

## Institute Level Optional Courses (ILOC)

| Semester II      |                                  |           |
|------------------|----------------------------------|-----------|
| Course Code      | Course Name                      | Credits   |
| <b>ESMIE2014</b> | <b>Human Resource Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

### Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

| Module | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Hrs |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| I      | <b>Introduction to HR</b> <ul style="list-style-type: none"> <li>Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.</li> <li>Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 5   |
| II     | <b>Organizational Behavior (OB)</b> <ul style="list-style-type: none"> <li>Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues</li> <li>Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness</li> <li>Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior.</li> <li>Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);</li> <li>Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.</li> <li>Case study</li> </ul> | 7   |
| III    | <b>Organizational Structure &amp; Design</b> <ul style="list-style-type: none"> <li>Structure, size, technology, Environment of organization; Organizational Roles &amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</li> <li>Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</li> <li>Power and Politics: Sources and uses of power; Politics at work place, Tactics and strategies.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                         | 6   |
| IV     | <b>Human resource Planning</b> <ul style="list-style-type: none"> <li>Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.</li> <li>Performance Appraisal Systems: Traditional &amp; modern methods, Performance Counseling, Career Planning.</li> <li>Training &amp; Development: Identification of Training Needs, Training Methods</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 5   |
| V      | <b>Emerging Trends in HR</b> <ul style="list-style-type: none"> <li>Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</li> <li>Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.</li> </ul>                                                                                                                                                                                                                                                                                                                     | 6   |
| VI     | <b>HR &amp; MIS</b><br>Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries)<br><b>Strategic HRM</b><br>Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals<br><b>Labor Laws &amp; Industrial Relations</b><br>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act                                                                                                                                                                                                                  | 10  |



### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **References:**

1. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed,2013
2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition,2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup>edition,2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

## Institute Level Optional Courses (ILOC)

| Semester II      |                                                                      |           |
|------------------|----------------------------------------------------------------------|-----------|
| Course Code      | Course Name                                                          | Credits   |
| <b>ESMIE2015</b> | <b>Professional Ethics and Corporate Social Responsibility (CSR)</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To understand professional ethics in business
2. To recognize corporate social responsibility

**Outcomes:** Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                 | Hrs |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>I</b>   | <b>Professional Ethics and Business:</b> The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business                                                                                                             | 04  |
| <b>II</b>  | <b>Professional Ethics in the Marketplace:</b> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy<br><b>Professional Ethics and the Environment:</b> Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources      | 08  |
| <b>III</b> | <b>Professional Ethics of Consumer Protection:</b> Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy<br><b>Professional Ethics of Job Discrimination:</b> Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs. | 06  |
| <b>IV</b>  | <b>Introduction to Corporate Social Responsibility:</b> Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection.<br>Trajectory of Corporate Social Responsibility in India                                        | 05  |

|    |                                                                                                                                                                                                                                                                          |    |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| V  | <b>Corporate Social Responsibility:</b> Articulation of Gandhian Trusteeship<br>Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India,<br>Corporate Social Responsibility and Public-Private Partnership (PPP) in India                       | 08 |
| VI | <b>Corporate Social Responsibility in Globalizing India:</b> Corporate Social<br>Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs,<br>Government of India, Legal Aspects of Corporate Social Responsibility—Companies<br>Act, 2013. | 08 |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **References:**

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

## Institute Level Optional Courses (ILOC)

| Semester II      |                             |           |
|------------------|-----------------------------|-----------|
| Course Code      | Course Name                 | Credits   |
| <b>ESMIE2016</b> | <b>Research Methodology</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

### Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                         | Hrs       |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I</b>   | <b>Introduction and Basic Research Concepts</b><br><b>1.1</b> Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology<br><b>1.2</b> Need of Research in Business and Social Sciences<br><b>1.3</b> Objectives of Research<br><b>1.4</b> Issues and Problems in Research<br><b>1.5</b> Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical | <b>09</b> |
| <b>II</b>  | <b>Types of Research</b><br><b>2.1.</b> Basic Research<br><b>2.2.</b> Applied Research<br><b>2.3.</b> Descriptive Research<br><b>2.4.</b> Analytical Research<br><b>2.5.</b> Empirical Research<br><b>2.6</b> Qualitative and Quantitative Approaches                                                                                                                                                                                                     | <b>07</b> |
| <b>III</b> | <b>Research Design and Sample Design</b><br><b>3.1</b> Research Design – Meaning, Types and Significance<br><b>3.2</b> Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors                                                                                                                                                                                         | <b>07</b> |

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>IV</b> | <b>Research Methodology</b><br><b>4.1</b> Meaning of Research Methodology<br><b>4.2.</b> Stages in Scientific Research Process:<br><b>a.</b> Identification and Selection of Research Problem<br><b>b.</b> Formulation of Research Problem<br><b>c.</b> Review of Literature<br><b>d.</b> Formulation of Hypothesis<br><b>e.</b> Formulation of research Design<br><b>f.</b> Sample Design<br><b>g.</b> Data Collection<br><b>h.</b> Data Analysis<br><b>i.</b> Hypothesis testing and Interpretation of Data<br><b>j.</b> Preparation of Research Report | <b>08</b> |
| <b>V</b>  | <b>Formulating Research Problem</b><br><b>5.1</b> Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis                                                                                                                                                                                                                                                                                                                                                                 | <b>04</b> |
| <b>VI</b> | <b>Outcome of Research</b><br><b>6.1</b> Preparation of the report on conclusion reached<br><b>6.2</b> Validity Testing & Ethical Issues<br><b>6.3</b> Suggestions and Recommendation                                                                                                                                                                                                                                                                                                                                                                     | <b>04</b> |

### **Assessment:**

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **References:**

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup>ed), Singapore, Pearson Education

## Institute Level Optional Courses (ILOC)

| Semester II      |                          |           |
|------------------|--------------------------|-----------|
| Course Code      | Course Name              | Credits   |
| <b>ESMIE2017</b> | <b>IPR and Patenting</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

### Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting
- 4.

| Module     | Detailed Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Hr |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>I</b>   | <b>Introduction to Intellectual Property Rights (IPR):</b> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.<br><b>Importance of IPR in Modern Global Economic Environment:</b> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development                                                                                         | 05 |
| <b>II</b>  | <b>Enforcement of Intellectual Property Rights:</b> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement<br><b>Indian Scenario of IPR:</b> Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc. | 07 |
| <b>III</b> | <b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.                                                                                                                                                                                                                                                                                                                                                                               | 05 |

|           |                                                                                                                                                                                                                                                                                                                                                                                     |    |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>IV</b> | <b>Basics of Patents:</b> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent | 07 |
| <b>V</b>  | <b>Patent Rules:</b> Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)                                                                                                                                                                | 08 |
| <b>VI</b> | <b>Procedure for Filing a Patent (National and International):</b> Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement<br><b>Patent databases:</b> Important websites, Searching international databases              | 07 |

### **Assessment:**

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **References:**

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer LawInternational
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7<sup>th</sup> Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3<sup>rd</sup> Edition,WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition,TMH
8. R Radha Krishnan& S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications

10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press



## Institute Level Optional Courses (ILOC)

| Semester II      |                                    |           |
|------------------|------------------------------------|-----------|
| Course Code      | Course Name                        | Credits   |
| <b>ESMIE2018</b> | <b>Digital Business Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

### Outcomes: The learner will be able to .....

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

| Module    | Detailed content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Hours |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>I</b>  | <b>Introduction to Digital Business-</b><br>Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts<br>Difference between physical economy and digital economy,<br><b>Drivers of digital business-</b> Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)<br>Opportunities and Challenges in Digital Business,                                                                                                                                                                                                                                                                                                               | 09    |
| <b>II</b> | <b>Overview of E-Commerce</b><br><b>E-Commerce-</b> Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement<br>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals<br>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing<br>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC | 06    |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| <b>III</b> | <b>Digital Business Support services:</b> ERP as e –business backbone, knowledge Tope Apps, Information and referral system<br><b>Application Development:</b> Building Digital business Applications and Infrastructure                                                                                                                                                                                                                                                             | 06 |
| <b>IV</b>  | <b>Managing E-Business-</b> Managing Knowledge, Management skills for e-business, Managing Risks in e –business<br>Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications | 06 |
| <b>V</b>   | <b>E-Business Strategy-</b> E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)                                                                                                                                                                                                                                       | 04 |
| <b>VI</b>  | <b>Materializing e-business: From Idea to Realization-</b> Business plan preparation Case Studies and presentations                                                                                                                                                                                                                                                                                                                                                                  | 08 |

### **Assessment:**

Internal:

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

### **References:**

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6<sup>th</sup> Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2<sup>nd</sup> Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2<sup>nd</sup> International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-en OECD Publishing

## Institute Level Optional Courses (ILOC)

| Semester II      |                                 |           |
|------------------|---------------------------------|-----------|
| Course Code      | Course Name                     | Credits   |
| <b>ESMIE2019</b> | <b>Environmental Management</b> | <b>03</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>03</b>       | --        | --       | <b>03</b>        | --        | --       | <b>03</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| 20                  | 20    | 20      | 80           | 03 Hrs.                  | --                       | -- | -- | 100   |

### Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarize environment related legislations

### Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

| Module     | Detailed Contents                                                                                                                                                                                                            | Hrs |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>I</b>   | Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities.<br>Environmental issues relevant to India, Sustainable Development, The Energy scenario. | 10  |
| <b>II</b>  | Global Environmental concerns: Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.                   | 06  |
| <b>III</b> | Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.                                                                                | 05  |
| <b>IV</b>  | Scope of Environment Management, Role & functions of Government as a planning and regulating agency.<br>Environment Quality Management and Corporate Environmental Responsibility                                            | 10  |
| <b>V</b>   | Total Quality Environmental Management, ISO-14000, EMS certification.                                                                                                                                                        | 05  |
| <b>VI</b>  | General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.                                                       | 03  |

### **Assessment:**

#### **Internal:**

Assessment consists of two tests out of which; one should be compulsory class test **(on minimum Two Modules)** and the other is either a class test or assignment on live problems or course project.

#### **End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

#### **References:**

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management **V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements with Guidance for Use, Bureau of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press  
Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing, 2015

| Semester II    |                                                      |           |
|----------------|------------------------------------------------------|-----------|
| Course Code    | Course Name                                          | Credits   |
| <b>ESML201</b> | <b>Measurement &amp; Virtual Instrumentation Lab</b> | <b>01</b> |

| Teaching Scheme |           |          |                  |           |          |       |
|-----------------|-----------|----------|------------------|-----------|----------|-------|
| Contact Hours   |           |          | Credits Assigned |           |          |       |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| --              | 02        | --       | --               | 01        | --       | 01    |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| --                  | --    | --      |              |                          |                          |    |    |       |
| --                  | --    | --      | --           | --                       | 25                       | 25 | -- | 50    |

#### Topic

**I. Study of sensor characteristics, selection, calibration and measurement of minimum 05 mechanical parameters such as flow, load, pressure, speed and temperature**

#### **II. Virtual Instrumentation (VI)**

a. Simulation of any system with Virtual Instrumentation environment using any suitable software

b. Interfacing of sensors used for measuring above mentioned parameters in I with VI software and measurement of these parameters on any laboratory model or actual working system

**III. Demonstration of interfacing of VI software with suitable generic hardware**

#### **Assessment:**

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners

| Semester II      |                             |           |
|------------------|-----------------------------|-----------|
| Course Code      | Course Name                 | Credits   |
| <b>ESMSBL201</b> | <b>Renewable Energy Lab</b> | <b>02</b> |

| Teaching Scheme |           |          |                  |           |          |           |
|-----------------|-----------|----------|------------------|-----------|----------|-----------|
| Contact Hours   |           |          | Credits Assigned |           |          |           |
| Theory          | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| --              | <b>04</b> | --       | --               | <b>02</b> | --       | <b>02</b> |

| Evaluation Scheme   |       |         |              |                          |                          |    |    |       |
|---------------------|-------|---------|--------------|--------------------------|--------------------------|----|----|-------|
| Theory              |       |         |              |                          | Term Work/Practical/Oral |    |    | Total |
| Internal Assessment |       |         | End Sem Exam | Duration of End Sem Exam | TW                       | PR | OR |       |
| Test1               | Test2 | Average |              |                          |                          |    |    |       |
| --                  | --    | --      |              |                          |                          |    |    |       |
| --                  | --    | --      | --           | --                       | 50                       | 50 | -- | 100   |

The laboratory will focus on the following,

1. Measurement of solar radiation and sunshine hours
2. Measurement of albedo, UV & IR radiation
3. Measurement of emissivity, reflectivity, transmittivity
4. Performance testing of solar flat plate water heater (forced flow & thermosyphon systems)
5. Performance testing solar air heater & dryer & desalination unit
6. Performance testing of solar thermal concentrators
7. Characteristics of photovoltaic devices & testing of solar PV operated pump
8. Testing of Gasifier or Wind machines or Fuel cell

### **Assessment:**

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners