



**MINUTES OF THE FORTY-THIRD MEETING OF THE ACADEMIC COUNCIL HELD ON 12 JUNE 2018 AT 10.30 A.M.**

**PRESENT**

The following members of the Academic Council attended the meeting:

**Members**

Dr Leena Srivastava, Chairperson  
Dr Rajiv Seth  
Dr Prateek Sharma  
Dr J K Garg  
Mr Rakesh Mehrotra  
Dr Vivek Suneja  
Dr Suresh Jain  
Dr Sapna A Narula  
Dr Nandan Nawn  
Dr Chaithanya Madhurantakam  
Dr Vishnu Konoorayar  
Dr Manipadma Datta  
Dr Atul Kumar  
Dr Kamna Sachdeva  
Dr Naqui Anwer  
Dr Anandita Singh  
Dr Anu Rani Sharma  
Capt. Pradeep Kumar Padhy (Retd.), Secretary

**Invitees**

Dr. Soumendu Sarkar;  
Mr Sapan Thapar  
Dr Neeti  
Dr Chubamenla Jamir  
Dr Akash Sondhi  
Dt Montu Bose  
Dr Abhijit Datey  
Dr C K Singh  
Dr VSP Sinha  
Dr Nithiyanandam Yogeswaran

Prof TC Kandpal, Dr Malathi Lakshmikumaran, Dr Anubha Kaushik, Dr Arun Kansal, Dr Shaleen Singhal, Dr Ramakrishnan Sitaraman and Ms Fawzia Tarannum could not attend the meeting.

The Vice Chancellor welcomed all the new members of the Academic Council and Invitees. The Council placed on record its deep sense of appreciation of the services rendered by outgoing members Dr Rakesh Kosha and Dr Kanchan Chopra during their tenure as member of the Academic council.

**ITEM NO.1 To confirm the minutes of the forty second meeting of the Academic Council held on 02 Apr 2018. The minutes of the forty second meeting of the Academic Council held on 02 Apr 2018, were circulated to the members and no comments have been received.**

**TS/AC 41.1.1** The Council resolved that the minutes of the meeting of the Academic Council held on 02 April 2018 be confirmed.

**ITEM NO. 2 To consider and approve Course Participation Certificate for Distance Education Programmes.** Mr Sapan Thapar Coordinator, Open and Distance Learning, intimated that a large number of students undergoing programmes conducted under the open and distance learning format were not able to complete their programmes because of various extraneous reasons. He proposed that a Certificate of Participation be issued to these students to help them join back the programmes at a time of their choosing within the permissible limits. He stated that this certificate would be issued to students who could score a minimum of 50% in all the assignments submitted. He presented the draft certificate to the Council. After deliberating the issue, the members recommended that instead of a certificate a letter of participation be issued to such students.

**TS/AC 43.2.1** The Council resolved that the participation letter as amended be accepted and approved (Annexure 1).

**ITEM NO.3. To consider and approve the outline of a few courses proposed by Department of Policy Studies.** The recommendations of the meeting of the Board of Studies of Department of Policy Studies held on 25 April 18 were placed before the Council. The following suggestions were provided:

- (a) **Growth Economics**
  - (i) To add a module and associated references on Kaldorian and Kaleckian growth models.
  - (ii) Format of references to be made as per a citation style.
  - (iii) Description and indicators of evaluation to be added.
- (b) **Development Economics**
  - (i) Assessment title to be changed “preparation of policy brief” to “policy brief” in the Evaluation section.
  - (ii) Description regarding practical in Module 1 to be added.
  - (iii) Description and indicators of evaluation to be added.
  - (iv) References are to be formatted as per a given citation style.
- (c) **Introduction to Mathematical Methods in Economics**
  - (i) Additional textbooks to be mentioned.
  - (ii) The word 'Introduction to' be dropped from the title.
  - (iii) Last module title to be changed to 'Application'.
- (d) **Microeconomics**
  - (i) Transaction costs to be introduced. In Module VIII “Markets as Institutions” to be introduced. Three papers were included in the list of readings as essential for this module.
  - (ii) Details of tutorials to be added in the section on “Pedagogical Approach”.
- (e) **Probability and Statistics**
  - (i) Goal of practical is to be reflected in the course objectives.
  - (ii) References are to be formatted as per a given citation style.
- (f) **Application of Quantitative Data Analysis in Development Practice**
  - (i) The word ‘advanced level’ in the 2<sup>nd</sup> bullet point of course objectives must be removed.
  - (ii) Details of ‘Tutorials’ (T) and Practical (P) (i.e. what is to be taught in Tutorials and Practical) are to be mentioned in the specific modules.
  - (iii) In the large-scale survey, ‘Census Surveys/Data’ may be included along with other surveys.  
(The course already included three large scale nationally reported surveys (NFHS, IHDS & NSSO). These three surveys are conducted by Govt. of India in a timely and systematic manner and are useful to the students of

development practice. Further, SDP students get detailed exposure to Census Data during the course on Population and Health: Techniques of Analysis and Policy Perspectives (MPD 124) offered in the 2<sup>nd</sup> semester. Considering the credit limit and no. of hours, feasibility of additional surveys is also difficult.)

(iv) The proposed evaluation criteria follow continuous evaluation system with terms paper presentation and submission. It was decided that students would be asked to present and submit first term paper by middle of the semester and another one by the end of the semester.

(v) The evaluation criteria be mapped as per the course outline. Two separate evaluation tasks provided to the students to match the two different modules. One module covers application of statistical analysis for small scale survey, while another covers use of large scale surveys for development practice.

(g) **Art and Sustainability**

(i) Course Matching with the university USP and a continuous evaluation system. The course description indicates that - This course is geared towards sensitizing students on different dimensions of sustainability by creating varying art forms through the core philosophical principles of introspection, reflection, action and liberation. While applying the four core principles of introspection, reflection, action and liberation, this course will delve into a liberating journey from the bonded sense of materialism by integrating notions of sustainability, efficiency and sufficiency while connecting with notions of human welfare and quality of life. This indicates that the basic premise of the course is based on the USP of the university. In the evaluation system the following tests are put in place -

- Test 1: A Book Review, Critical Analysis: 40% weightage
- Test 2: A sustainability product formation (short story, poetry, any type of literary output, painting, short documentary, dance video, music composition, any other art form according to the interest of the student): 40% weightage
- Test 3: Class Room Participation: 20% weightage. Class room participation will be captured by discussing issues of artefacts, tribal arts and how in the context of an issue of equity and justice these arts have a valuable contribution.
- These tests will ensure that all sustainability products are opened for an online voting and display on the campus for voting by faculties and management to ensure transparent, fair assessment of students. No marking system will be done on the sustainability product. Based on the votes gathered by each sustainability product the performance of the students will be continuously assessed. For the book review and class room participation, the student with more original, out of the box thinking and perspectives will be graded higher. This will ensure that constant evaluation takes place.
- As a part of Test 3, within the class room 5 groups will be created and a question related to certain themes surrounding sustainability will be asked. Each group will be then asked to present their narration of the exploration done by the group collectively while addressing the question on a particular theme centering around sustainability by using any art form of their interest which they will present to all the other groups. If a group does well, then all group members in that group will be rewarded for

giving incentives of collective thinking while addressing sustainability questions.

- This is done to create a continuous evaluation system.

(ii) Course is mapped with learning outcomes: -

- The course will have three tests. The three tests will comprise of - a) Test 1: A Book Review, Critical Analysis: 40% weightage, b) Test 2: A sustainability product formation (short story, poetry, any type of literary output, painting, short documentary, dance video, music composition, any other art form according to the interest of the student): 40% weightage and c) Test 3: Class Room Participation: 20% weightage. Class room participation will be captured by discussing issues of artefacts, tribal arts and how in the context of an issue of equity and justice these arts have a valuable contribution.

- Each test has been linked to the learning outcomes in the following manner:

- Have the ability to create and sustain a self – reflective (**Test 1& 3**), empathetic (**Test 2**), experimental perspective (**Test 2**) about bridging philosophies between the theoretical, experimental and practical aspects of social, economic and environmental domains of sustainability.

- Will be able to create application of different art forms in their professional and public life with three main components viz. reflection, action and liberation (**Test 2**).

- Will be able to create a collective thinking around issues and principles of equity and justice surrounding sustainability by using different art forms (**Test 3**).

(iii) Course is fair, transparent and unbiased in the assessment of students: The tests will be opened up through online voting and peer review based collective performance system within the classroom to ensure a transparent, fair and unbiased assessment of students and their performance in the class.

**TS/AC 43.3.1** The Council resolved that the outlines of the following Courses placed at Annexure 2 be accepted as amended and approved: -

| Ser                     | Course  | Type     | Credits |
|-------------------------|---|----------|---------|
| <b>M.Sc (Economics)</b> |   |          |         |
| 1                       | Growth Economics*   | Core     | 4       |
| 2                       | Development Economics*  | Core     | 4       |
| 3                       | Mathematical Methods for Economics**                                      | Core     | 4       |
| 4                       | Microeconomics  | Core     | 4       |
| 5                       | Environment and Economic Development                                      | Core     | 4       |
| 6                       | Probability and Statistics**  | Core     | 4       |
| 7                       | Econometrics  | Core     | 4       |
| <b>MA (SDP)</b>         |   |          |         |
| 1                       | Application of Quantitative Data Analysis in Development Practice (SDP)** | Elective | 2       |
| <b>Common</b>           |   |          |         |
| 1                       | Art and Sustainability*   | Elective | 2       |

\* *New Courses*

\*\* *New Title*

**ITEM NO. 4. To consider and approve the revision in the programme structure of MSc (Economics) Programme.** The recommendations of the meeting of the Board of Studies of Department of Policy Studies held on 25 Apr 18 w.r.t. MSc (Economics) programmes were placed before the Council. The following suggestions were given:-

- (a) Economics of Natural Resource title be changed to Natural Resource Economics.
- (b) Economics of the Environment title be changed to Environmental Economics.

**TU/AC 43.4.1** The Council resolved that revised structure of MSc (Economics) programme as under be accepted as amended and approved. The Council recommended that the structured feedback from various stakeholders be obtained in order to take inputs on the programme structure and analysis of the same be presented in the next Academic Council:-

| <b>Restructured Outline of MSc Economics programme</b> |  |                |
|--|--|----------------|
| <b>Year/Semester</b>                                   | <b>Courses</b>   | <b>Credits</b> |
| <b>First year</b>                                      |  | <b>32</b>      |
| 1st Semester   | <b>4 Core courses of 4 credits</b>   | <b>16</b>      |
|  | Probability and Statistics   | 4              |
|  | Macroeconomics   | 4              |
|  | Microeconomics   | 4              |
|  | Introduction to Mathematical Methods for Economics                                   | 4              |
| 2nd Semester   | <b>4 Core courses of 4 credits</b>   | <b>16</b>      |
|  | Environment and Economic Development   | 4              |
|  | Growth Economics   | 4              |
|  | Development Economics  | 4              |
|  | Econometrics   | 4              |
| <b>Second year</b>                                     |  | <b>40</b>      |
| 3 <sup>rd</sup> Semester                               | <b>3 Core courses of 4 credits + Elective courses of 8 credits</b>                   | <b>20</b>      |
|  | Core 1: Methods of Research in Economics   | 4              |
|  | Core 2: Environmental Economics  | 4              |
|  | Core 3: Natural Resource Economics   | 4              |
|  | Elective courses from those offered in the MSc Economics programme or open electives | 8              |
| 4 <sup>th</sup> Semester                               | <b>Master's Thesis</b>   | <b>20</b>      |

**ITEM NO.5. To consider and approve the revised structure of M.Sc (Geoinformatics) Programme.** The recommendations of the meeting of the Board of Studies of Department of Natural Resources held on 16 Mar 18 w.r.t. M.Sc (Geoinformatics) were placed before the Council.

**TU/AC 43.5.1** The Council resolved that the following revised structure of MSc (Geoinformatics) programme be accepted as amended and approved: -

| <b>Year/Semester</b>       | <b>Courses</b>                                      | <b>Type</b> | <b>Credits</b> |
|----------------------------|---|-------------|----------------|
| <b>1<sup>st</sup> year</b> |   |             |                |
| 1st Semester               | Total credits (5+0/1/2 Core Courses + 1 Core Audit) |             | <b>15</b>      |
|                            | Principles of Cartography                           | Core        | 3              |

|                            |   |                   |           |
|----------------------------|---|-------------------|-----------|
|                            | Principles of Remote Sensing                        | Core              | 3         |
|                            | Principles of GIS and GNSS                          | Core              | 4         |
|                            | Environmental Statistics                            | Core              | 3         |
|                            | Fundamentals of Computers and Programming           | Core              | 2         |
|                            | Applied Mathematics                                 | Core*<br>(Audit)  | -         |
|                            | Fundamentals of Physics                             | Core**<br>(Audit) | -         |
|                            | Technical Writing                                   | Core<br>(Audit)   | -         |
| 2nd Semester               | Total credits                                       |                   | <b>19</b> |
|                            | Photogrammetry                                      | Core              | 3         |
|                            | Digital Image Processing and Information Extraction | Core              | 4         |
|                            | Spatial Data Modelling and its Applications         | Core              | 4         |
|                            | Multivariate Data Analysis                          | Core              | 3         |
|                            | Programming in Geoinformatics                       | Core              | 3         |
|                            | Law and Policy for Maps and Remote Sensing          | Core              | 2         |
|                            | Project Management                                  | Core<br>(Audit)   | -         |
|                            | Research Methodology and Thesis Writing             | Core<br>(Audit)   | -         |
| <b>2<sup>nd</sup> year</b> |   |                   |           |
| 3 <sup>rd</sup> Semester   | Total Credits                                       |                   | <b>21</b> |
|                            | Advances in Remote Sensing                          | Core              | 4         |
|                            | Advances in GIS and current trend                   | Core              | 4         |
|                            | Geoinformatics Applications for Land Resources      | Core              | 3         |
|                            | Geoinformatics Applications for Water Resources     | Core              | 3         |
|                            | Geoinformatics Applications for Atmosphere          | Core              | 3         |
|                            | Minor Project (during summer break)                 | Core              | 2         |
|                            | Geocomputation                                      | Elective          | 3         |
| 4 <sup>th</sup> Semester   | Total Credits                                       |                   | <b>15</b> |
|                            | Major Project                                       |                   | 15        |

**ITEM NO. 6 To consider and approve the outline of a few courses for MSc (Geoinformatics) Programme.** The recommendations of the meeting of the Board of Studies of Department of Natural Resources held on 16 March 18 w.r.t. MSc (Geoinformatics) were placed before the Council. Dr Garg informed that a thorough review of the individual modules has been carried out by the BoS and the external faculty. A detailed discussion was held on the course outlines. As per the suggestion of Dean Academic, learning outcomes and evaluation criteria for all the five courses were revisited and revised.

**TU/AC 43.6.1** The Council resolved that outlines of the following five courses of MSc (Geoinformatics) programme be accepted as amended (vide Annexure 3) and approved: -

| Ser | Course                       | Type | Credit |
|-----|------------------------------|------|--------|
| 1   | Principles of Cartography    | Core | 3      |
| 2   | Principles of GIS and GNSS   | Core | 4      |
| 3   | Principles of Remote Sensing | Core | 3      |

|   |   |       |   |
|---|---|-------|---|
| 4 | Fundamentals of Computers and Programming | Core  | 2 |
| 5 | Fundamentals of Physics                   | Audit | 2 |

**ITEM NO. 7 To consider and approve revised structure of MBA (Business Sustainability) Programme..** The recommendations of the meeting of the Board of Studies of Department of Business & Sustainability held on 22 May 18 w.r.t. MBA (Business Sustainability) were placed before the Council. A detailed discussion was held on the programme structure.

**TU/AC 43.7.1** The Council resolved that revised structure of MBA (Business Sustainability) programme as under be accepted as amended and approved. The Council recommended that the structured feedback from various stakeholders be obtained in order to take inputs on the programme structure and analysis of the same be presented in the next Academic Council: -

| Year/Semester              | Course Title                                | Type     | Credits      |
|----------------------------|---|----------|--------------|
| <b>1<sup>st</sup> Year</b> |   |          |              |
| 1 <sup>st</sup> Semester   | Total Credits                               |          | 23           |
|                            | Principles and concepts of sustainability   | Core     | 2            |
|                            | Business ethics                             | Core     | 2            |
|                            | Sustainability Reporting                    | Core     | 2            |
|                            | Managerial economics                        | Core     | 3            |
|                            | Marketing management                        | Core     | 3            |
|                            | Fundamentals of Management                  | Core     | 2            |
|                            | Business communication                      | Core     | 3            |
|                            | Statistical methods for management          | Core     | 3            |
|                            | Corporate accounting and reporting          | Core     | 3            |
| 2nd Semester               | Total Credits                               |          | 21           |
|                            | Legal aspects of business                   | Core     | 2            |
|                            | Qualitative research methods in management  | Core     | 2            |
|                            | Strategies for Sustainable Business         | Core     | 3            |
|                            | Macroeconomic Environment                   | Core     | 3            |
|                            | Corporate Finance                           | Core     | 3            |
|                            | Management Information System               | Core     | 2            |
|                            | Advanced statistical methods for management | Core     | 2            |
|                            | Corporate Social Responsibility             | Core     | 2            |
|                            | Organizational behaviour and leadership     | Core     | 2            |
| <b>2<sup>nd</sup> year</b> |   |          |              |
| 3rd Semester               | Total Credits                               |          | 21<br>(15+6) |
|                            | Accounting and finance for sustainability   | Core     | 3            |
|                            | Minor Project                               | Core     | 6            |
|                            | Entrepreneurship                            | Core     | 2            |
|                            | Supply chain management                     | Core     | 2            |
|                            | Business, Natural Ecosystems and Community  | Core     | 2            |
|                            | Health Finance                              | Elective | 3            |
|                            | Corporate governance                        | Elective | 2            |
|                            | Sustainable consumption and production      | Elective | 2            |
|                            | Techniques of environmental valuation       | Elective | 4            |
|                            | Financial intermediaries, institutions and  | Elective | 2            |

|                             |  |          |    |
|-----------------------------|--|----------|----|
|                             | regulations  |          |    |
|                             | Integrated impact assessment                                       | Elective | 4  |
|                             | Derivatives and risk management                                    | Elective | 2  |
|                             | International financial management                                 | Elective | 2  |
|                             | Business to business marketing                                     | Elective | 2  |
|                             | Urban Governance   | Elective | 4  |
|                             | Environmental management system                                    | Elective | 4  |
|                             | Brand management   | Elective | 2  |
|                             | Security Analysis and portfolio management                         | Elective | 2  |
|                             | Production and Operations Management                               | Elective | 3  |
|                             | Consumer behavior  | Elective | 2  |
|                             | Project design and management for sustainable development practice | Elective | 4  |
|                             | Social Entrepreneurship  | Elective | 2  |
|                             | Design Thinking  | Elective | 2  |
| 4 <sup>th</sup><br>Semester | Major project  | Core     | 14 |

**ITEM NO.8 To consider and approve the revised programme structure of MBA (Infrastructure).** The recommendations of the meeting of the Board of Studies of Department of Business & Sustainability held on 22 May 18 w.r.t. MBA (Infrastructure) were placed before the Council. A detailed discussion was held on the programme structure.

**TU/AC 43.8.1** The Council resolved that revised structure of MBA (Infrastructure) programme as under be accepted as amended and approved. The Council recommended that the structured feedback from various stakeholders be obtained in order to take inputs on the programme structure and analysis of the same be presented in the next Academic Council:-

| Year/<br>Semester           | Course Title  | Type | Credits |
|-----------------------------|---|------|---------|
| 1 <sup>st</sup> year        |   |      |         |
| 1 <sup>st</sup><br>Semester | Total Credits   |      | 20      |
|                             | Module 1 Basics of Infrastructure Business                  |      |         |
|                             | Introduction to Infrastructure Business                     | Core | 2       |
|                             | Economics of Infrastructure and Pricing Strategies          | Core | 2       |
|                             | Infrastructure project finance                              | Core | 2       |
|                             | Corporate Accounting and Reporting                          | Core | 2       |
|                             | Corporate Finance   | Core | 2       |
|                             | Statistical methods for management                          | Core | 3       |
|                             | Module 2 Law & Policy Framework for Infrastructure Business |      |         |
|                             | Legal & Regulatory aspects of infrastructure                | Core | 2       |
|                             | Business Laws and Infrastructure projects                   | Core | 2       |
|                             | Contracts Laws  | Core | 2       |
|                             | Environmental and Social Laws                               | Core | 1       |
| 2 <sup>nd</sup><br>Semester | Total Credits   |      | 20      |
|                             | Module 1 Strategy and Risk                                  |      |         |
|                             | Business Ethics   | Core | 1       |
|                             | Strategic planning  | Core | 2       |



|                                |  |          |              |
|--------------------------------|--|----------|--------------|
|                                | Risk analysis and Implementation Management                  | Core     | 3            |
|                                | Project planning and management                              | Core     | 2            |
|                                | Bidding System Management                                    | Core     | 1            |
|                                | Module 2 Operational aspects of Infrastructure               |          |              |
|                                | Quality Management   | Core     | 2            |
|                                | Management information systems                               | Core     | 2            |
|                                | Infrastructure organization and HR                           | Core     | 3            |
|                                | Logistics and supply chain management                        | Core     | 2            |
|                                | Macroeconomic Environment                                    | Core     | 3            |
| <b>2<sup>nd</sup> Year</b>     |  |          |              |
| <b>3<sup>rd</sup> Semester</b> | Total Credits  |          | 23<br>(17+6) |
|                                | Minor Project  | Core     | 6            |
|                                | Integrated impact assessment                                 | Core     | 3            |
|                                | Public Private Partnership                                   | Core     | 2            |
|                                | Corporate governance   | Core     | 2            |
|                                | Innovation and change management for infrastructure projects | Core     | 2            |
|                                | Strategic communication and stakeholder engagement           | Core     | 2            |
|                                | Advanced Logistics and Supply Chain Management               | Elective | 2            |
|                                | Accounting and finance for sustainability                    | Elective | 3            |
|                                | Financial intermediaries, institutions and markets           | Elective | 2            |
|                                | Sustainable Urban Transport                                  | Elective | 2            |
|                                | Entrepreneurship   | Elective | 2            |
|                                | Urban water supply and waste management                      | Elective | 2            |
|                                | Business to business marketing                               | Elective | 2            |
| Total credits                  |  |          |              |
| <b>4<sup>th</sup> Semester</b> | Major Project  | Core     | 14           |

**ITEM NO. 9 To consider and approve the outlines of new Courses for MBA (Business Sustainability/ Infrastructure).** The recommendations of the meeting of the Board of Studies of Department of Business & Sustainability held on 22 May 18 w.r.t. MBA (Business Sustainability/ Infrastructure) were placed before the Council. A detailed discussion was held on the course outlines. The following suggestions were provided:

(a) **Health Finance**

- (i) The title of the course may be revised for alignment with the content of the course.
- (ii) Learning outcomes to be linked with evaluation.
- (iii) Health care system should be discussed before we talk about the financing.
- (iv) Different financing mechanism like – publicly funded, provided by the private sector and PP should be included.
- (v) Other issues of health system like insurance coverage, availability of the healthcare services could be discussed.
- (vi) If the course title includes the word “sustainable” then sustainability for whom should be clearly mention.

- (vii) Pricing mechanism of insurance company, their profitability etc. should be taught in the course.
- (b) **Fundamentals of Management**
- (i) Management of family owned businesses, contemporary forms of organizations, platforms and networks including blockchains, and usage of AI/analytics to be included.
  - (ii) Title of module 6 to be rephrased.
  - (iii) Focus on inter-firm linkages and management of such linkages to be added.
  - (iv) Title of the course to be revisited for specificity/alignment with course content.
  - (v) Learning outcomes to be linked with evaluation components; details for evaluation to be added.
  - (vi) Presentations by students to be included over and above 28 hours of teaching.
- (c) **Organisational Behaviour and leadership**
- (i) The title of the course must be Organisational Behaviour and Leadership.
  - (ii) Topics on Trust in organizational context, corporate governance and leadership, and followership, sexual harassment may be added.
  - (iii) Learning outcomes to be linked with evaluation components; details for evaluation to be added.
  - (iv) Presentations by students to be included over and above 28 hours of teaching.
- (d) **Sustainability Reporting**
- (i) Learning outcomes to be linked with evaluation components.
  - (ii) Topic on Science based targets may be added.
- (e) **Advanced Logistics and Supply Chain Management**
- (i) Suggestion to incorporate (a) the usage of IT/AI/Analytics in Logistics and Supply Chain Management and (b) linking of regional value chains with global value chains.
  - (ii) Learning pack to be elaborated in terms of suggested books, weblinks, articles, research papers, case studies etc.
  - (iii) Learning outcomes to be defined and linked with evaluation.
- (f) **Design Thinking**
- (i) Suggestion to increase the number of credits from 1 to 2 to cover the course content intensively.
  - (ii) Learning outcomes to be linked with evaluation components.
- (g) **Social Entrepreneurship**
- (i) The course needs major revision as it lacks theoretical grounding in the present form. To incorporate the same, the number of credits may be increased from 1 to 2.
  - (ii) Learning outcomes to be linked with evaluation components.
- (h) **Corporate Social Responsibility**
- (i) Learning outcomes to be linked with evaluation components.
  - (ii) Suggestion to keep philanthropy out of the context of this course.
- (i) **Business, Ecosystem and Community**
- (i) Suggested title for the course- Business, Natural Ecosystems and Community.
  - (ii) The title of the first module of the course may be revised.
  - (iii) Aquatic systems/ wetlands ecosystems; abiotic structure to be added.

- (iv) First module to be focused on imparting fundamental knowledge of ecosystem structure and functioning.
- (v) Social cost benefit analysis, basic duties of corporate citizens, valuation of externalities may be added as some sub-topics.
- (vi) Formatting may be revisited and learning outcomes to be linked with evaluation components.
- (vii) The course content may be revisited in places for more clarity Linkage/collaboration with organizations like Tatas to be explored for practical exposure.

(j) **Additional Comments**

- (i) Nomenclature of the individual courses in MBA (Business Sustainability) and MBA (Infrastructure) to be revisited.
- (ii) A course on Business Analytics could be introduced as an elective in the MBA programmes.

**TU/AC 43.9.1** The Council resolved that outlines of the following courses of MBA (Business Sustainability/Infrastructure) programme be accepted as amended (vide Annexure 4) and approved: -

| Ser                                    | Course                                       | Type     | Credit |
|--|--|----------|--------|
| Business Sustainability/Infrastructure |  |          |        |
| 1                                      | Health Finance                               | Elective | 3      |
| 2                                      | Fundamentals of Management                   | Core     | 2      |
| 3                                      | Organizational Behaviour and Leadership      | Core     | 2      |
| 4                                      | Sustainability Reporting                     | Core     | 2      |
| 5                                      | Advanced Logistics & Supply Chain Management | Elective | 2      |
| 6                                      | Design Thinking                              | Elective | 1      |
| 7                                      | Social Entrepreneurship                      | Elective | 1      |
| 8                                      | Corporate Social Responsibility              | Core     | 2      |
| 9                                      | Business, Natural Ecosystems and Community   | Core     | 2      |

**ITEM NO. 10 : To consider and approve the outlines of new Courses for M.Tech (UDM).** The recommendations of the meeting of the Board of Studies of Department of Energy & Environment held on 17 May 18 w.r.t. M.Tech (UDM) were placed before the Council. A detailed discussion was held on the course outlines.

**TU/AC 43.10.1:** The Council resolved that outlines of the following courses of M.Tech (UDM) programme be accepted as amended (vide Annexure 5) and approved: -

| Ser | Course  | Type | Credit |
|-----|---|------|--------|
| 1   | Urban Governance                                    | Core | 3      |
| 2   | Introduction to Geographic Information System (GIS) | Core | 1      |

**ITEM NO. 11 To consider and approve the outlines of new Courses for 3<sup>rd</sup> Semester of MSc (CSP).** The recommendations of the meeting of the Board of Studies of Department of Energy & Environment held on 17 May 18 w.r.t. 3<sup>rd</sup> Semester of MSc (CSP) were placed before the Council. A detailed discussion was held on the structure.

**TU/AC 43.11.1** The Council resolved that the following revised structure for 3<sup>rd</sup> Semester of MSc (CSP) programme be accepted as amended and approved:-

| Ser                      | Courses   | Type | Cr |
|--------------------------|---|------|----|
| 3 <sup>rd</sup> Semester | 1 Core course of 3 credits + Electives courses of 12 credits (can choose any four from this |      | 15 |

|   |          |   |
|---|----------|---|
| bouquet)  |          |   |
| The electives are grouped into two streams; (i) Climate Science and technology, and (ii) Climate Policy and Development. Students will be asked to choose any four from these electives |          |   |
| Seminar course on Global environmental change   | Core     | 3 |
| Climate Science and Technology  |          |   |
| Ecosystem and Climate Change  | Elective | 3 |
| Advanced Climate Modelling  | Elective | 3 |
| Aerosol Science   | Elective | 3 |
| Renewable Energy Technologies   | Elective | 3 |
| Geoinformatics for Natural resource management  | Elective | 3 |
| Glacier hydrology   | Elective | 3 |
| Satellite Meteorology   | Elective | 3 |
| Energy System Modeling  | Elective | 3 |
| Independent study   | Elective | 3 |
| Climate Policy and Development  |          |   |
| Climate Change and Disaster Risk Reduction  | Elective | 3 |
| Economics of Climate Change   | Elective | 3 |
| Food Security and Agriculture   | Elective | 3 |
| Public Health and Development: Issues and Methods   | Elective | 3 |
| Accounting and Finance for Sustainability   | Elective | 3 |
| Governance of Climate Change  | Elective | 3 |
| Independent study   | Elective | 3 |

**ITEM NO. 12(a) To consider and approve the outlines of new Courses for MSc (CSP).** The recommendations of the meeting of the Board of Studies of Department of Energy & Environment held on 17 May 18 w.r.t. MSc (CSP) were placed before the Council. A detailed discussion was held on the course outlines and following suggestions were provided:-

(a) **Ecosystem and Climate Change:**

- (i) map outcomes of the course with given modules. Also, if practical component is involved then its list should be provided.
- (ii) The topic on theory of Assembly Rules be incorporated in Model 2.
- (iii) The Learning Outcomes to be mapped with the Course Objectives.
- (iv) Details of the Evaluation Criteria to be provided.

(b) **Disaster Risk Reduction.** Headings to each module should be provided. Ecosystem approach (Eco DRR) of disaster reduction should be incorporated.

(c) **Advance Climate modeling.** map outcomes of the course with given modules. Also, if practical component is involved then its list should be provided.

(c) **Economics of Climate Change:**

- (i) Discussion around nomenclature happened and it was suggested that Economics of Environment and Climate change cannot be used together: The nomenclature was therefore changed to "Economics of Climate Change".
- (ii) Last module of the course needs major changes as currently it does not cover economics at all.
- (iii) Outcomes of the course and evaluation should be mapped.
- (iv) The last model considers the economic principles that have been applied in devising the institutional mechanisms for dealing with climate change. I
- (v) Term Paper – mapped with points (2) & (3) of Course Objectives and point (2) of Learning Outcomes. End-Semester Major Exam – Mapped with points (1), (2) & (3) of Course Objectives and point (1) of Learning Outcomes. Assignments – Mapped with point (1) of Course Objectives and point (1) of Learning Outcomes.

(d) **Renewable Energy and Technologies.** Need to define how this course is different from other renewable energy courses offered in REEM program. Objective of the course should clearly define this aspect. Moreover, this needs to realign with respect to CSP program.

**TU/AC 43.12(a).1** The Council resolved that outlines of the following six courses of MSc (CSP) programme be accepted as amended (vide Annexure 6) and approved: -

| Ser. | Course                                      | Type     | Credit |
|------|---|----------|--------|
| 1    | Ecosystems and Climate Change*              | Elective | 3      |
| 2    | Climate Change and Disaster Risk Reduction* | Elective | 3      |
| 3    | Advance Climate Modelling*                  | Elective | 3      |
| 4    | Economics of Climate Change                 | Elective | 3      |
| 5    | Renewable Energy Technologies*              | Elective | 3      |
| 6    | Energy Systems Modeling*                    | Elective | 3      |

**ITEM NO. 12 (b): To consider and approve Change of teaching hours of Applied mathematics bridge Audit course for M.Sc (CSP) programme.** Dr Kamana informed that during earlier program revision, 10 hours of bridge course was introduced in CSP program for new students who had not studied mathematics up to 10+2 standard. She stated that it was realized that students needed additional hours to grasp sufficient knowledge of mathematics. She therefore proposed that 3 credit course (NRE 113) which was initially part of the program be restored.

**TU/AC 43.12(b)** The Council resolved the changes of teaching hours of Applied mathematics bridge Audit course of MSc (CSP) programme be accepted as amended and approved.

**ITEM NO.13 To consider and approve the outline of courses for MTech (REEM) Programme.**

The recommendations of the meeting of the Board of Studies of Department of Energy & Environment held on 17 May 18 w.r.t. MTech (REEM) were placed before the Council. A detailed discussion was held on the course outlines. The followings were suggested and action has been taken accordingly: -

- (a) **Energy audit and management**
  - (i) Best practices for ECM in industries to be added.
  - (ii) Programmes like EESL to be introduced.
  - (iii) Distribution of contact hours for each module to be revisited with emphasis on experiential learning.
- (b) **Energy Simulation Laboratory**
  - (i) Rationale for allocating lecture hours in a laboratory course.

- (ii) Distribution of contact hours for each module to be revisited.
- (c) **Grid Integration of Renewable Energy.** The word “etc” to be removed from the Module 6, in a way, the topics of the case studies should be explicitly mentioned.
- (d) **Waste to Energy**
- (i) Whether the course is technology centric or project centric?
- (ii) Financial/economic analysis of waste to energy plant to be included.
- (e) **Solar Photovoltaic Power Generation**
- (i) In Module 6, the topics of case studies to be explicitly mentioned. One suggestions is to write “Case Studies based on module 1, 2, 3, 4 and 5”, if deemed fit.
- (ii) In Module 7 (Financial analysis and environmental benefits), the topics i.e. performance analysis and energy payback, financial analysis, and CO<sub>2</sub> mitigation needs further explanation like which financial tool is to be used.
- (f) **Independent Study**
- (i) The eligibility criteria of CGPA to be 7.5 or above to be revisited and rationale for it to be mentioned.
- (ii) Since the course is not a project work, then why a report is required to be submitted at the end for final evaluation? In this way the evaluation criteria and procedure to be revisited.
- (g) **Smart Grid.** The Module 6 to be modified, no need to mention the word Rural. It could be ‘application of smart grids’ or something like that.

**TU/AC 43.13.1:** The Council resolved that outlines of the following eight courses of MTech (REEM) programme be accepted as amended (vide Annexure 7) and approved: -

| Ser | Course                               | Type     | Credit |
|-----|--------------------------------------|----------|--------|
| 1   | Energy Audit and Management          | Elective | 3      |
| 2   | Energy Simulation Laboratory         | Core     | 3      |
| 3   | Grid Integration of Renewable Energy | Elective | 3      |
| 4   | Waste to Energy                      | Elective | 2      |
| 5   | Solar Thermal Power Generation       | Elective | 3      |
| 6   | Solar Photovoltaic Power Generation  | Elective | 3      |
| 7   | Independent Study                    | Elective | 3      |
| 8   | Smart Grid                           | Elective | 2      |

**ITEM NO. 14. Extension of maximum period for submission of thesis.** The Registrar informed the council that a doctoral candidate was expected to submit his/her thesis within five years from the date of registration and the period might be extended by Academic Council as a special case. He stated that the following candidates who had registered for PhD programme require extension since they have completed the 5 years period as indicated below.

Ms Achla Khanna (1011RPA) - Extension of a year w.e.f 02 July 2017#

Mr Vipin Kumar (1031RPB) - Extension of a year w.e.f 12 July 2017#

Ms Tanu Sri (1124RBB) – Extension of a year w.e.f.07 July 2018

#: *Synopsis submitted in July, 2017. Thereafter thesis not submitted. New Synopsis being submitted*

The Registrar informed that on the recommendation of the supervisor, approval was sought for an extension of one year in respect of above candidates for the submission of their theses.

**TU/AC 43.14.1** The Council resolved that one-year extension be accorded to:-

Ms Achla Khanna (1011RPA) - w.e.f 02 July 2017

Mr Vipin Kumar (1031RPB) - w.e.f 12 July 2017

Ms Tanu Sri (1124RBB) – w.e.f.07 July 2018

Sd/

Capt Pradeep Kumar Padhy (retd.)

Registrar

**Enclosures:-**

Annexure 1

Annexure 2

Annexure 3

Annexure 4

Annexure 5

Annexure 6

Annexure 7

**Distribution:-**

Electronic Copy

1. Vice-Chancellor, TERI School of Advanced Studies
2. All members of the Academic Council
3. Website

Printed Copy

4. Registrar, TERI School of Advanced Studies

10, INSTITUTIONAL AREA, VASANT KUNJ, NEW DELHI – 110 070



**LETTER OF PARTICIPATION**

**TO WHOMSOEVER IT MAY CONCERN**

Mr **XXXX** has enrolled in the Certificate course in “XXYY” (through Open and Distance Learning mode) during the period XXYY to XXYY and has partially\* completed the requirements for the award of the “Certificate in XXYY”.

Sd/-  
Centre Head

Dated: XXXX

Registration date: XX-XX-XXXX

| Marksheet for “Certificate in XXYY” |            |                   |         |
|-------------------------------------|------------|-------------------|---------|
| Module Name                         | Assignment | Semester End Exam | Grade   |
| Introduction to Renewable Resources | XX/100     | XX/100            | B       |
| Solar Technologies                  | XX/100     | Pending           | Pending |
| Wind Technologies                   | XX/100     | XX/100            | Pending |
| Energy Analysis                     | XX/100     | Pending           | Pending |
| <<Name of Module>>                  |            |                   |         |



| <b>Course title:</b> Growth Economics   |   |                          |                                      |                           |
|---|---|--------------------------|--------------------------------------|---------------------------|
| <b>Course code:</b> MPE XXX   |   | <b>No. of credits:</b> 4 | <b>L-T-P:</b> 56-0-0                 | <b>Learning hours:</b> 56 |
| <b>Pre-requisite course code and title (if any):</b> MPE111 (Introduction to Mathematical Methods in Economics) or equivalent   |   |                          |                                      |                           |
| <b>Department:</b> Department of Policy Studies   |   |                          |                                      |                           |
| <b>Course coordinator:</b> TBD  |   |                          | <b>Course instructor:</b> TBD        |                           |
| <b>Contact details:</b> TBA   |   |                          |                                      |                           |
| <b>Course type:</b> Core  |   |                          | <b>Course offered in:</b> Semester 2 |                           |
| <b>Course description:</b><br>This course introduces theories of economic growth and their applications with an emphasis on application to India's economic growth. Dynamic macroeconomic models are used here to analyse the process of economic growth. Besides the models, other empirical tools will also be used to identify factors that lead to economic growth in India and other developing nations.   |   |                          |                                      |                           |
| <b>Course objectives:</b><br>1. Understanding the factors that lead to economic growth of nation-states.<br>2. To equip the students with tools and techniques to appreciate and analyse dynamic macroeconomic models and empirical strategies that can explain the process of economic growth.<br>3. To foreground the role(s) played by the institutions, human capital and environment in the economic growth.<br>Enabling the students to evaluate the application of concepts, theories and models in explaining India's economic growth.  |   |                          |                                      |                           |
| <b>Course contents</b>  |   |                          |                                      |                           |
| Module  | Topic   | L                        | T                                    | P                         |
| 1   | Introduction;<br>Cross country differences in Income;<br>A narrative on India's economic growth | 4                        | 0                                    | 0                         |
| 2   | Harrod-Domar Model  | 4                        | 0                                    | 0                         |
| 3   | Kaldorian and Kaleckian Growth Models   | 6                        | 0                                    | 0                         |
| 4   | Solow Model   | 4                        | 0                                    | 0                         |
| 5   | Solow Growth Accounting   | 4                        | 0                                    | 0                         |
| 6   | Neo-Classical Growth Models: Introduction   | 6                        | 0                                    | 0                         |
| 7   | Models with Overlapping Generations   | 4                        | 0                                    | 0                         |
| 8   | Empirics: Cross-country Differences in Economic Performances                                    | 6                        | 0                                    | 0                         |
| 9   | Endogenous Growth Models  | 6                        | 0                                    | 0                         |
| 10  | Institutions and Economic Growth  | 4                        | 0                                    | 0                         |
| 11  | Human Capital and Economic Growth   | 4                        | 0                                    | 0                         |
| 12  | Environment and Economic Growth   | 4                        | 0                                    | 0                         |
| <b>Total (in hours)</b>   |   | <b>56</b>                | <b>0</b>                             | <b>0</b>                  |
| <b>Evaluation criteria:</b><br>1. Test 1: Written examination (Modules 1 to 5) [30%]<br>2. Test 2: Assignments [10%]<br>3. Test 3: Written examination (Modules 6 to 12) [30%]<br>4. Test 4: Term Paper (Critical Literature Review) [30%]<br>a. Task: Undertake a critical appraisal of literature on any topic listed in the syllabus.<br>b. Structure of submission: A paper that consists of introduction; summary of the literature; critique of the literature with supportive evidence; application in Indian context, synthesis and conclusion.<br>c. Indicators of assessment: selection of appropriate literature (weightage: 5%); clear and concise summaries (weightage: 30%); critique that is supported by evidence using author's calculations or by literature (weightage: 40%); effective introduction and conclusion (weightage: 10%); well-structured essay with no grammatical errors (weightage: 10%); and appropriate format of citations and references (weightage: 5%). |   |                          |                                      |                           |

**Learning outcomes:**

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

1. Understand different macroeconomic models of growth. [test 1 and 3]
2. Appreciate empirical strategies in Growth Economics [test 2]
3. Identify factors that have influenced economic growth in India and the associated policy implications [test 1 and 3]
4. Understand the contribution of institutions and human capital to economic growth as well as limits of growth imposed by natural resources and environmental degradation. [test 3]
5. Assess the applicability of economic growth models in India and other developing nations. [test 4]

**References (\* = compulsory readings)****Books**

- a. Acemoglu, Daron. 2009. *Introduction to Modern Economic Growth* (DA henceforth), Princeton: Princeton University Press.
- b. Sen, Amartya. 1970. *Growth Economics – Selected Readings*, Middlesex, England: Penguin.
- c. Aghion, Philippe and Peter W. Howitt. 2008. *The Economics of Growth*, Cambridge MA: MIT Press.
- d. Robert J. Barro and Xavier I. Sala-i-Martin. 1998 *Economic Growth*, Cambridge MA: MIT Press,
- e. Romer, David. 2018. *Advanced Macroeconomics*, 5<sup>th</sup> Ed. (DR henceforth) New York: McGraw Hill.

**Suggested Readings**

1. *Introduction; Cross-country differences in income; A narrative of India's growth story*

- a. DA – Chapter 1
- b. Jones, Charles I. 1997. "On the Evolution of the World Income Distribution." *Journal of Economic Perspectives* 11, no. 3 (Summer): 19-36.
- c. Basu, K., and A. Maertens. 2007. "The Pattern and Causes of Economic Growth in India." *Oxford Review of Economic Policy*, 23(2): 143-167.
- d. Rodrik, D., and A. Subramanian. 2005. "From Hindu Growth" to Productivity Surge: The Mystery of the Indian Growth Transition." IMF Staff Papers, Palgrave Macmillan, 52(2), 193-228.
- e. Binswanger-Mkhize, Hans P. 2013. "The Stunted Structural Transformation of the Indian Economy Agriculture, Manufacturing and the Rural Non-Farm Sector" *Review of Rural Affairs, EPW supplement*, vol. xlviii nos. 26 & 27: 5-12  
[http://www.epw.in/system/files/pdf/2013\\_48/2627/The\\_Stunted\\_Structural\\_Transformation\\_of\\_the\\_Indian\\_Economy.pdf](http://www.epw.in/system/files/pdf/2013_48/2627/The_Stunted_Structural_Transformation_of_the_Indian_Economy.pdf)

2. *Harrod-Domar Model*

- a. Harrod, Roy F. 1939. "An Essay in Dynamic Theory". *The Economic Journal*. 49 (193): 14–33.
- b. Domar, E. 1946. "Capital Expansion, Rate of Growth, and Employment". *Econometrica*. 14 (2): 137–147.

3. *Kaldorian and Kaleckian Growth Models*

- a. Kaldor, N. 1957. "A Model of Economic Growth." *The Economic Journal*, 67(268): 591-624. doi:10.2307/2227704
- b. Setterfield, Mark and John Cornwall. 2002. "A Neo-Kaldorian Perspective on the Rise and Decline of the Golden Age." In *The Economics of Demand-Led Growth*, edited by Setterfield. M., 67-86. Mass: Edward Elgar Publishing.
- c. Amitava Krishna Dutt. 2012. "Kaleckian Growth Theory: An Introduction," *Metroeconomica*, vol. 63(1): 1-6
- d. Blecker, Robert. 2002. "Distribution, Demand and Growth in Neo-Kaleckian Macro-Models." In *The Economics of Demand-Led Growth*, edited by Setterfield. M., 129-152. Mass: Edward Elgar Publishing.
- e. Sawyer, Malcolm. 2012. "The Kaleckian Analysis of Demand-Led Growth, *Metroeconomica*, vol. 63(1):7-28.

#### 4. Solow Model

- a. DA – Chapter 2
- b. Solow, Robert. 2000. *Growth Theory: An Exposition*. 2nd ed. NY: Oxford University Press, ISBN: 9780195109030
- c. DeLong, J. B. 2003. "India since Independence: An analytic growth narrative." In *In Search of Prosperity: Analytic Narratives on Economic Growth*, edited by D. Rodrik: 184-204. Princeton NJ: Princeton University Press.
- d. Robertson, Peter E. 2010. "Investment Led Growth in India: Fact or Mythology", *Economic and Political Weekly*, 45(40): 120-124.

#### 5. Solow Growth Accounting

- a. DA – Chapter 3
- b. Bosworth, Barry & Susan M. Collins & Arvind Virmani. 2006. "Sources of Growth in the Indian Economy," *India Policy Forum*, vol. 3: 1-6.  
[http://www.ncaer.org/publication\\_details.php?pid=161](http://www.ncaer.org/publication_details.php?pid=161)

#### 6. Neo-classical Growth Models (Ramsey-Cass-Koopman model)

a. DA Chapter 5; Chapter 8

#### 7. Growth with Overlapping Generations

- a. DA Chapter 9
- b. Ghate, Chetan, Gerhard Glomm and Jialu Liu Streeter. 2016. "Sectoral Infrastructure Investments in an Unbalanced Growing Economy: The Case of Potential Growth in India", *Asian Development Review*, 33(2): 144-166.
- c. Agénor, P., J. Mares and P. Sorsa. 2015. "Gender Equality and Economic Growth in India: A Quantitative Framework", *OECD Economics Department Working Papers, No. 1263*, OECD Publishing, Paris.  
<http://dx.doi.org/10.1787/5jrtpbnt7zf4-en>

#### 8. Endogenous Growth Models

- a. DA Chapter 11
- b. Madsen, Jakob B., Shishir Saxena, and James B Ang. 2010. "The Indian growth miracle and endogenous growth." *Journal of Development Economics*, vol. 93(1): 37-48.

#### 9. Empirics: Determinants of differences in economic performances

- a. DA Chapter 4
- b. Mankiw, N. Gregory, David Romer, and David N. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics*, 107 (2): 407-437.
- c. Young, Alwyn. 1995. "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience." *Quarterly Journal of Economics* 110(3): 641-680.
- d. Hall, Robert, and Charles I. Jones. 1999. "Why Do Some Countries Produce So Much More Output per Worker than Others?" *Quarterly Journal of Economics* 114(1): 83-116.
- e. Quah, Danny. 1997. "Empirics for Growth and Distribution: Stratification, Polarization, and Convergence Clubs." *Journal of Economic Growth*, 2(1): 27-59.
- f. Kumar, Utsav and Arvind Subramanian. 2012 "Growth in India's States in the First Decade of the 21st Century: Four Facts." *Economic and Political Weekly*, 47(3): 48-57.

#### 10. Institutions and Economic Growth

- a. DA- Ch 24, 25, 26 North, Douglass C. 1989. "Institutions and economic growth: An historical introduction." *World Development*, Vol 17(9): 1319-1332. [https://doi.org/10.1016/0305-750X\(89\)90075-2](https://doi.org/10.1016/0305-750X(89)90075-2) Acemoglu, Daron, Simon Johnson, and James A. Robinson. (2001) "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review* 91, no. 5 (December 2001): 1369-1401
- b. Alesina, Alberto and Dani Rodrik. (1994) "Distributive Politics and Economic Growth."

*Quarterly Journal of*

- c. *Economics*, Vol. 109, No. 2 (May, 1994), pp. 465-490
  - d. Acemoglu, Daron and Simon Johnson and James Robinson, "Reversal of fortune: Geography and institutions in the making of the modern world income distribution," *Quarterly Journal of Economics*, Vol. 117(4): 1231-1294.  
<http://www.gdsnet.org/UnderstandingProsperityandPoverty.pdf>
- Subramanian, A. 2007. "The evolution of institutions in India and its relationship with economic growth." *Oxford Review of Economic Policy*, 23(2): 196-220.

#### 11. Human Capital and Economic Growth

- a. Mankiw, G., D. Romer, D. Weil, . 1992. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Macroeconomics*, 107 (May) :407-437.
- b. Benhabib, Jess and Mark M. Spiegel. 1994. "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data." *Journal of Monetary Economics*, Vol. 34(2):143-173.
- c. Hanushek, Eric and Dennis Kimko (2000) "Schooling, Labor-Force Quality, and the Growth of Nations." *American Economic Review*, Vol. 90 (5) :1184-1208.
- d. Krueger, Alan B. and Mikael Lindahl. 2001. "Education for Growth: Why and For Whom?" *Journal of Economic Literature*, Vol. 39(4):1101-1136.
- e. Moretti, Enrico. 2004. "Workers' Education, Spillovers and Productivity: Evidence from Plant-Level Production Functions." *American Economic Review*, Vol. 94(3):656-690.
- f. Ghate Chetan, Gerhard Glommand John T. Stone III. 2015 "Public and Private Expenditures on Human Capital Accumulation in India." *WIDER Working Paper Series 024*, World Institute for Development Economic Research (UNU-WIDER).
- g. Rao, B. Bhaskara and Krishna Chaitanya Vadlamannati. 2010. "The level and growth effects of human capital in India." *Applied Economics Letters*, 18(1): 59-62, DOI: 10.1080/13504850903427146
- h. Schündeln, Matthias and John Playforth. 2014. "Private versus social returns to human capital: Education and economic growth in India." *European Economic Review*, vol. 66(C): 266-283.

#### 12. Environment and Economic Growth

- a. DR - Ch 1.8
- b. Brock, William A. and M. Scott Taylor. 2005. "Economic Growth and the Environment: A Review of Theory and Empirics," In *Handbook of Economic Growth* Edited by Philippe Aghion & Steven Durlauf (ed.), Handbook of Economic Growth, edition 1, volume 1: 1749-1821. Amsterdam: North Holland.
- c. William Brock and M. Taylor. 2010. "The Green Solow model," *Journal of Economic Growth*, vol. 15(2): 127-153.
- d. Bovenberg, A.L., and S. Smulders. 1995. "Environmental Quality and Pollution Augmenting Technological Change in a Two Sector Endogenous Growth Model." *Journal of Public Economics*, Vol 57(3): 369-391.
- e. Grossman G.M., and A. B. Krueger. 1995. "Economic Growth and the Environment." *Quarterly Journal of Economics*, vol. 110(2): 353-377.
- f. John, A. and R. Pecchenino. 1994. "An Overlapping Generations Model of Growth and the Environment." *The Economic Journal*, 104(427): 1393-1410.

#### **Additional information (if any):**

Suggested journals—*Journal of Economic Perspectives*, *Journal of Development Economics*, *Journal of Economic Growth*, *Indian Economic Review*

#### **Pedagogical Approach:**

- Classroom teaching
- Emphasis on solving neoclassical growth models and calibration
- Replicating important empirical results through matrix programming languages like MATLAB/R

**Student responsibilities:** Attendance, feedback, discipline: as per university rules.

**Course reviewers:**

1. Prof. Chetan Ghate, Indian Statistical Institute, Delhi Center, 7, S. J. S. Sansanwal Marg, New Delhi, Delhi 110016
2. Dr. Mausumi Das, Delhi School of Economics, University Enclave, Delhi, 110007

|   |  |                          |                                      |                      |
|---|--|--------------------------|--------------------------------------|----------------------|
| <b>Course title:</b> Development Economics  |  |                          |                                      |                      |
| <b>Course code:</b> MPE XXX   |  | <b>No. of credits:</b> 4 |                                      | <b>L-T-P:</b> 54-0-4 |
| <b>Learning hours:</b> 56   |  |                          |                                      |                      |
| <b>Pre-requisite course code and title (if any):</b> MPE 131 (Microeconomics) or equivalent   |  |                          |                                      |                      |
| <b>Department:</b> Department of Policy Studies   |  |                          |                                      |                      |
| <b>Course coordinator:</b> TBD  |  |                          | <b>Course instructor:</b> TBD        |                      |
| <b>Contact details:</b> TBA   |  |                          |                                      |                      |
| <b>Course type:</b> Core  |  |                          | <b>Course offered in:</b> Semester 2 |                      |
| <b>Course description:</b><br>This course introduces the students to challenges of economic development in India and the rest of the world. The introductory module offers a foundation for the course. The course offers an understanding of both historical trends and the present status of poverty, inequality and well-being in developing countries with an emphasis on empirical challenges in the estimation of these indicators. It also offers a microeconomic perspective of aspects that enable (or act as barriers) to economic development broadly categorized into functioning of markets (of the factors of production), political and social institutions. In each module, the students will examine the relevant theories, empirical validity of the theories (especially in the context of the Indian economy) and the associated policy implications. |  |                          |                                      |                      |
| <b>Course objectives:</b><br>1. To introduce the students to theoretical and empirical issues pertaining to economic development.<br>2. To expose students to data and measurement issues of development indicators.<br>3. To enable students in analysing constraints to economic development.<br>4. To develop an understanding on India's economic development challenges.<br>5. To equip the students with tools and techniques used in the research in economic development.<br>6. To develop capacity among the students for research in policy domain.   |  |                          |                                      |                      |
| <b>Course contents</b>  |  |                          |                                      |                      |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>                 | <b>T</b>                             | <b>P</b>             |
| 1   | <b>Introduction</b><br>1.1 Evolution of development economics<br>1.2 Understanding the economic lives of the poor<br>1.3 Development Analysis: Selected issues pertaining to data and causal inference. Practical: Introduction to development data in India, with a focus on national level household surveys like NSSO, IHDS, etc. Understanding data documentations, identifying methodology of survey and compilation of data and assessing the limitations of the data. | 2<br>2<br>4              |                                      | 4                    |
| 2   | <b>Outcomes of the Development Process</b><br>2.1 Conceptualizing well-being and poverty; measurement of poverty; debates on assessment of poverty in India; Anti-poverty programs.<br>2.2 Understanding Inequality; Measurement of Inequality; Inequality in India  | 6<br>6                   |                                      |                      |
| 3   | <b>Markets and Market Failures</b><br>3.1 Employment and wage determination in developing countries; mobility of labour; informal labour markets.<br>3.2 Rural land markets, property rights, tenancy contracts.<br>3.3 Role of financial capital markets in developmental process; credit and insurance markets in agrarian economies; evaluation of microfinance model as an alternate to traditional banking.   | 6<br>6<br>8              |                                      |                      |
| 4   | <b>Institutions and Development</b><br>4.1 Government failure as barrier to development: case studies of corruption and ineffective provisioning of public goods<br>4.2 Social institutions as barrier to development: social discrimination; impact of caste, religion and gender discrimination on developmental outcomes in India.<br>4.3 Social institutions as enablers of development: social networks   | 6<br>4<br>4              |                                      |                      |
| 5   | <b>Way Forward</b>   | 2                        |                                      |                      |

| Total (in hours)   | 54 | 4 |
|--|----|---|
| <p><b>Evaluation Criteria</b></p> <p>Test 1: Empirical Exercise [20%]</p> <ol style="list-style-type: none"> <li>Task: Replication of empirical analysis of any existing literature on any topic in groups of 3 or 4 students</li> <li>Structure of submission: A report that consists of the summary of the existing literature; outline of empirical method; data sources; interpretation of the results; class presentation and discussion.</li> <li>Indicators of assessment: content (all items outlined in (b) above), structure and quality of the report (weightage: 75%); content and quality of presentation of the report in the class (weightage: 25%).</li> </ol> <p>Test 2: Critical Review of Literature [30%]</p> <ol style="list-style-type: none"> <li>Task: Undertake a critical appraisal of literature on any topic listed in the syllabus.</li> <li>Structure of submission: A paper that consists of introduction; summary of the literature; critique of the literature with supportive evidence; synthesis and conclusion</li> <li>Indicators of assessment: selection of appropriate literature (weightage: 5%); clear and concise summaries (weightage: 30%); critique that is supported by evidence using author's calculations or by literature (weightage: 40%); effective introduction and conclusion (weightage: 10%); well-structured essay with no grammatical errors (weightage: 10%); and appropriate format of citations and references (weightage: 5%).</li> </ol> <p>Test 3: Written examination [30%]</p> <p>Test 4: Policy Brief [20%]</p> <ol style="list-style-type: none"> <li>Task: Carry out a comprehensive literature survey on any topic with policy relevance; identify policy suggestions from the literature; evaluate the applicability of the policy suggestions in India's context; assess potential risks of the policy; draft a policy brief for a non-technical audience.</li> <li>Structure of submission: policy brief that outlines the developmental challenge; policy gaps in India; policy suggestions based on evidence in the literature, expected outcomes, an assessment of potential risks of implementation of the policy, conclusion.</li> <li>Indicators of assessment: content and quality of policy brief (weightage 75%); depth of literature survey (weightage 25%)</li> </ol> <p>Note: Same topics may not be selected for Test1, 2 and 4</p> |    |   |
| <p><b>Learning outcomes:</b></p> <p>At the end of this course, students will be able to</p> <ol style="list-style-type: none"> <li>1. Conceptualize the developmental challenges in India and other developing nations. (Evaluation: All components)</li> <li>2. Understand theories and empirics in Development Economics. (Evaluation: All components)</li> <li>3. Understand data and empirical methods used in development analysis (Evaluation: Empirical Exercise)</li> <li>4. Critically appreciate the literature in Development Economics (Evaluation: Critical Review of Literature)</li> <li>5. Synthesize Evidence for Policy (Evaluation: Policy Brief Assignment)</li> <li>6. Demonstrate Soft skills: written and verbal communication; critical thinking; team work</li> </ol>   |    |   |
| <p><b>References (* = compulsory readings)</b></p> <p><b>Books</b></p> <p><i>Textbooks</i></p> <p>*Bardhan, Pranab and Christopher Udry. 1999. <i>Development Microeconomics</i>, Oxford: Oxford University Press. (BU henceforth)</p> <p>Ghate, Chetan ed. 2012. <i>The Oxford Handbook of the Indian Economy</i>, New York: Oxford University Press (CG henceforth)</p> <p>Ray, Debraj, (1998) <i>Development Economics</i>, Princeton: Princeton University Press. (DR henceforth)</p> <p><i>Others</i></p> <p>Banerjee, Abhijit, Roland Benabou and Dilip Mookherjee (2006), eds. <i>Understanding Poverty</i>, New York: Oxford University Press.</p> <p><b>Suggested Readings (module-wise)</b></p> <p><b>1. Introduction</b></p> <p><i>Evolution of Development Economics</i></p> <ol style="list-style-type: none"> <li>a. DR – Ch 1</li> <li>b. BU – Ch 1</li> </ol>  |    |   |

- c. \*Bardhan, Pranab. 1993. "Economics of Development and the Development of Economics." *J. Econ. Perspectives*, 7(2): 129-42.
- d. \*Banerjee, Abhijit, and Esther Duflo. 2006. "Economic Lives of the Poor." *Journal of Economic Perspectives* 21(1): 141-167.
- e. Banerjee, Abhijit, and Esther Duflo. 2008. "What is Middle Class About the Middle Classes Around the World?" *Journal of Economic Perspectives* 22(4): 3-28.

#### *Data and Methods for Development Economics*

- a. \*Deaton, Angus. 1997. *The Analysis of Household Surveys: Microeconomic Analysis for Development Policy*. Baltimore: Johns Hopkins University Press for the World Bank.
- b. Ravallion, M. 2001. "The mystery of the vanishing benefits: An introduction to impact evaluation." *World Bank Economic Review*, vol 15(1) :115-140.  
<http://wber.oxfordjournals.org/content/vol15/issue1/index.dtl>.
- c. Duflo, Esther, Rachel Glennerster, and Michael Kremer. 2008 "Using Randomization in Development Economics Research: A Toolkit." In *Handbook of Development Economics*, Vol. 4. Edited by T. Schultz and John Strauss, Amsterdam: North Holland.
- d. Deaton, Angus, and Nancy Cartwright. 2018. "Understanding and misunderstanding randomized controlled trials." *Social Science & Medicine*, in press. <https://www.sciencedirect.com/science/article/pii/S0277953617307359?via%3Dihub>.
- e. Esther Duflo. 2005. "Field Experiments in Development Economics." *BREAD Policy Paper 12*.
- f. Basu, Kaushik. 2014. "Randomization, Causality and the Role of Reasoned Intuition," *Oxford Development Studies*, 42(4): 455-472. DOI: 10.1080/13600818.2014.961414.
- g. Athey, S., & Imbens, G. 2017. "The State of Applied Econometrics: Causality and Policy Evaluation." *The Journal of Economic Perspectives*, 31(2): 3-32. Retrieved from <http://www.jstor.org/stable/44234997>.

## **2. Outcomes of the Development Process**

### *Poverty and Inequality*

- a. DR – Chapters 6, 7, 8.
- b. BU – Chapter 11.
- c. \*Houghton, Jonathan; Shahidur RKhandker. 2009 *Handbook on Poverty and Inequality*. Washington, DC: World Bank. <https://openknowledge.worldbank.org/handle/10986/11985>  
License: CC BY 3.0 IGO.
- d. \*Stephen P. Jenkins and Philippe Van Kerm. 2011 "The Measurement of Economic Inequality" In *The Oxford Handbook of Economic Inequality*. Edited by Brian Nolan, Wiemer Salverda, and Timothy M. Smeeding. Oxford: Oxford University Press DOI: 10.1093/oxfordhb/9780199606061.013.000.
- e. \*Dreze, J and Deaton, A. 2002. "Poverty and Inequality in India: A Re-examination." *Economic and Political Weekly*, Vol. 37(36): 3729-3748.
- f. \*Himanshu and Sen, K. 2014. "Revisiting the Great Indian Poverty Debate: Measurement, Patterns, and Determinants" *BWPI Working Paper 203*.  
[http://www.bwpi.manchester.ac.uk/medialibrary/publications/working\\_papers/bwpi-wp-20314.pdf](http://www.bwpi.manchester.ac.uk/medialibrary/publications/working_papers/bwpi-wp-20314.pdf)
- g. Deaton, A. and V. Kozel, 2005. "Data and Dogma: The Great Indian Poverty Debate." *The World Bank Research Observer* 20 (2): 177-200.  
[http://www.princeton.edu/~deaton/downloads/deaton\\_kozel\\_great\\_indian\\_poverty\\_debate\\_wbro\\_2005.pdf](http://www.princeton.edu/~deaton/downloads/deaton_kozel_great_indian_poverty_debate_wbro_2005.pdf)
- h. \*Martin Ravallion. 2008. "Evaluating Anti-Poverty Programs" In *Handbook of Development Economics*, Vol. 4. Edited by T. Schultz and John Strauss, Amsterdam: North Holland.
- i. \*Alkire, Sabine and Suman Seth, 2015. "Multidimensional Poverty Reduction in India between 1999 and 2006: Where and How?" *World Development* 72: 93-108. Also published as OPHI Working Papers 60, 2013.
- j. Borooah, Vani and Amaresh Dubey. 2007. "Measuring Regional Backwardness: Poverty Gender and Children in the districts of India." *Margin: The Journal of Applied Economic Research*, Vol 1(4): 403 – 440.
- k. Chancel, L. and Picketty, T. 2017 "Indian income inequality, 1922-2015: From British Raj to Billionaire Raj?" *WID.world Working Paper Series N° 2017/11*. Available at:



<http://wid.world/document/chancelpiketty2017widworld/>.

### 3. Markets and Market failures

#### Labour Markets

- a. BU – Chapter 4, 5
- b. DR – Chapter 10, 13
- c. \*Mark R. Rosenzweig. 1995. "Labor Markets in Low-Income Countries: Distortions, Mobility and Migration." *Handbook in Development Economics* (Alternate version: <http://www.rrojasdatabank.info/edc87-05.pdf> )
- d. \*Freeman R. (2009) "Labor Regulations, Unions, and Social Protection in Developing Countries: Market Distortion or Efficient Institutions." In: *Handbook of Development Economics*. Amsterdam: North Holland(Alternate version: <http://www.nber.org/papers/w14789.pdf>)
- e. Gordon Hanson (2008) "International Migration and Development." *Commission on Growth and Development Working Paper #42*[http://siteresources.worldbank.org/EXTPREMNET/Resources/489960-1338997241035/Growth\\_Commission\\_Working\\_Paper\\_42\\_International\\_Migration\\_Development.pdf](http://siteresources.worldbank.org/EXTPREMNET/Resources/489960-1338997241035/Growth_Commission_Working_Paper_42_International_Migration_Development.pdf)
- f. Yang, Dean.2008. "International Migration, Human Capital, and Entrepreneurship: Evidence from Philippine Migrants' Exchange Rate Shocks." *The Economic Journal*, Vol. 118 (April): 591-630.
- g. \*Deshingkar, Priya and Shaheen Akter.2009."Migration and Human Development in India." *MPRA Paper 19193*, University Library of Munich, Germany.
- h. Nandi, Tushar Kanti and Saibal Kar.2015. "Short-term Migration and Intergenerational Persistence of Industry in Rural India." *IZA Discussion Papers 9283*, Institute for the Study of Labor (IZA).
- i. Czaika, M. (2012) "Internal and international migration as a response of double deprivation: some evidence from India." *Asian Population Studies*, 8(2), pp. 125–149
- j. \*Mitra, Arup and Dibyendu Maity. 2010. "Skills, Informality and Development." *IEG working paper #WP306*, <http://iegindia.org/upload/publication/Workpap/wp306.pdf>
- k. Kanbur, Ravi.2009. "Conceptualising Informality: Regulation and Enforcement." *Cornell University, Department of Applied Economics and Management, Working Paper 09-11*
- l. CG – Chapter 9
- m. Marjit, Sugata and Saibal Kar. 2012. "Informal Sector and Developing World: Relating Theory and Evidence to India" in: Ghate, Chetan ed. *The Oxford Handbook of the Indian Economy*, New York: Oxford University Press

#### Land

- a. \*BU – Chapter 6
- b. DR – Chapter 12
- c. Besley, T. and R. Burgess. 2000. "Land Reform, Poverty Reduction, and Growth: Evidence from India." *Quarterly Journal of Economics*, vol. 115(2): 389-430.
- d. \*Banerjee, A., P. Gertler, and M. Ghatak. 2002. "Empowerment and Efficiency: Tenancy Reform in West Bengal." *Journal of Political Economy*, 110(2): 239-280. doi:10.1086/338744.
- e. Galiani, Sebastian and Ernesto Scharfgrösky. 2010. "Property rights for the poor: Effects of land titling." *Journal of Public Economics*, vol. 94(9-10): 700-729.
- f. Binswanger-Mkhize, Hans P., Camille Bourguignon and Rogier van den Brink.2009. "Agricultural Land Redistribution: Toward Greater Consensus." World Bank Publications, The World Bank, <https://openknowledge.worldbank.org/handle/10986/2653>.
- g. \*Besley, Timothy and Maitreesh Ghatak., 2010. "Property Rights and Economic Development." *Handbook of Development Economics*, Elsevier. (alternate version: Besley, Timothy and Maitreesh Ghatak.2009. "Property rights and economic development." LSE Research Online Documents on Economics 25428, London School of Economics and Political Science, LSE Library.)
- h. \*Binswanger, Hans, P. Deininger, Klaus and Feder, Gershon (1995) "Power, distortions, revolt, and reform in agricultural land relations", *Handbook of Development Economics*, Elsevier

(alternative version:

<http://documents.worldbank.org/curated/en/304261468764712147/pdf/multi-page.pdf>).

#### *Capital, Credit, Insurance*

- a. \*BU – Chapter 7, 8
- b. DR – Chapter 14, 15
- c. CG – Chapter 5, 6.
- d. Eswaran, Mukesh, and Ashok Kotwal. 1989. "Credit as Insurance in Agrarian Economies." *Journal of Development Economics* 31(1):37–53.
- e. Jonathan Morduch. 2002. "Between the State and the Market: Can Informal Insurance Patch the Safety Net?" *World Bank Research Observer*, 14, no. 2, 187–207.
- f. \*Karlan, D. and Morduch J. 2010. "Access to Finance." in *Handbook of Development Economics*. Also available at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.205.6947&rep=rep1&type=pdf>.
- g. \*Besley, B. 1995. "Savings, Credit and Insurance." *Handbook of Development Economics*, Vol 3A. Also available at: [https://www.princeton.edu/rpds/papers/Besley\\_Savings\\_Credit\\_and\\_Insurance\\_HDE1995.pdf](https://www.princeton.edu/rpds/papers/Besley_Savings_Credit_and_Insurance_HDE1995.pdf).
- h. \*Maitra, Pushkar, Sandip Mitra, Dilip Mookherjee, Alberto Motta and Sujata Visaria, (2014) "Financing Smallholder Agriculture: An Experiment with Agent-Intermediated Microloans in India" *NBER Working Paper No. 20709* <http://www.nber.org/papers/w20709>.
- i. \*Field, Erica, Rohini Pande, John Papp, and Natalia Rigol. 2013 "Does the Classic Microfinance Model Discourage Entrepreneurship among the Poor? Experimental Evidence from India." *American Economic Review* 103(6):2196-2226.
- j. Pande, Rohini, and Burgess, Robin. 2005. "Do Rural Banks Matter? Evidence from the Indian Social Banking Experiment." *American Economic Review*, 95(3):780-794.

#### **4. Institutions and Development**

##### *Political Institutions*

- a. \*Banerjee, A. J. Iyer and Somanathan. R. (2008) "Public Action for Public Goods" *Handbook of Development Economics*, Vol. 4, *Ch II.1*. Edited by T. Schultz and John Strauss, Amsterdam: North Holland.
- b. \*Pande, Rohini. (2008) "Understanding Political Corruption in Low Income Countries" *Handbook of Development Economics*, Vol. 4, *Ch II.2*. Edited by T. Schultz and John Strauss, Vol. 4. Amsterdam: North Holland.

##### *Social Discrimination and Social Networks*

- a. \*Basu, Kaushik. 2015. "Discrimination as a Coordination Device: Markets and the Emergence of Identity." *World Bank Policy Research Working Paper 7490*.
- b. Vegard Iversen. 2012. "Caste and Upward Mobility." In *The Oxford Handbook of the Indian Economy*, edited by Ghate, Chetan. New York: Oxford University Press.
- c. \*Munshi, Kaivan and Mark Rosenzweig (2009) "Why is Mobility in India so Low? Social Insurance, Inequality and Growth," *NBER Working Paper No. 14850*.
- d. \*Madheswaran, S and P. Attewell. 2007. "Caste Discrimination in the Indian Urban Labor Market: Evidence from the National Sample Survey", *Economic & Political Weekly*, vol. 42(41): 4146–4153.
- e. Field, E., S. Jayachandran, and R. Pande. 2010. "Do Traditional Institutions Constrain Female Entrepreneurship? A Field Experiment on Business Training in India." *The American Economic Review*, Vol. 100(2):125-129 <http://www.jstor.org/stable/27804976>.
- f. Munshi, K. 2007 "From Farming to International Business: The Social Auspices Of Entrepreneurship In A Growing Economy." *NBER Working Paper – 13065* <http://www.nber.org/papers/w13065>.
- g. Singh, Prerna and Dean Spears. 2017. "How status inequality between ethnic groups affects public goods provision: Experimental evidence on caste and tolerance for teacher absenteeism in India." *WIDER Working Paper Series 129*, World Institute for Development Economic Research (UNU-WIDER).
- h. \*Kaivan Munshi and Mark Rosenzweig. 2006 "Traditional Institutions Meet the Modern World: Caste, Gender, and Schooling Choice in a Globalizing Economy." *American Economic Review*,

- American Economic Association, vol. 96(4): 1225-1252.
- i. Greif, Avner. 1993. "Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition." *American Economic Review*, 83(3): 525-548.

### 5. Way Forward

- a. Kotwal, A. 2012. "What more do we want to know about the Indian Economy" In *The Oxford Handbook of the Indian Economy*, edited by Ghate, Chetan, New York: Oxford University Press.
- b. Banerjee, Abhijit Pranab Bardhan, Kaushik Basu, Ravi Kanbur and Dilip Mookherjee. 2005. "New Directions in Development Economics: Theory or Empirics? A Symposium in Economic and Political Weekly, <http://www.arts.cornell.edu/poverty/kanbur/NewDirectionsDevEcon.pdf>

### Pedagogical Approach:

- Classroom teaching
- Emphasis on reading and questioning empirical literature in Development Economics

**Additional information (if any):** Suggested journals—*Journal of Economic Perspectives*, *Journal of Development Economics*, *Indian Economic Review*.

**Student responsibilities:** Attendance, feedback, discipline: as per university rules.

### Course reviewers:

1. Prof. Bharat Ramaswamy, Indian Statistical Institute, Delhi Center, 7, S. J. S. Sansanwal Marg, New Delhi, Delhi. 110016.
2. Prof. Tridip Ray, Indian Statistical Institute, Delhi Center, 7, S. J. S. Sansanwal Marg, New Delhi, Delhi. 110016.

### Prepared by

Seema Sangita

|  |  |   |                           |          |
|--|--|---|---------------------------|----------|
| <b>Course title:</b> Mathematical Methods for Economics  |  |   |                           |          |
| <b>Course code:</b> MPE 111  | <b>No. of credits:</b> 4   | <b>L-T-P:</b> 42-14-0                     | <b>Learning hours:</b> 56 |          |
| <b>Pre-requisite course code and title (if any):</b> None. However, knowledge of Mathematics at the level of 10+2 is required.   |  |   |                           |          |
| <b>Department:</b> Department of Policy Studies  |  |   |                           |          |
| <b>Course coordinator:</b> Soumendu Sarkar   |  | <b>Course instructor:</b> Soumendu Sarkar |                           |          |
| <b>Contact details:</b> soumendu.sarkar@terisas.ac.in  |  |   |                           |          |
| <b>Course type:</b> Core   |  | <b>Course offered in:</b> Semester 1      |                           |          |
| <b>Course description:</b><br>The use of optimization techniques in economics can be motivated by Robbins' (1932) definition of economics as "the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses". This course brings together central results in Linear Algebra and Real Analysis to provide the foundation of constrained optimization techniques used in modern economics. However, Linear Algebra and Real Analysis are important topics in their own right, and many results thereof are used in different branches of economics. Besides equipping the student with economists' essential toolbox, this course emphasises on understanding important mathematical properties that motivate the underlying assumptions of economic models. |  |   |                           |          |
| <b>Course objectives:</b>  |  |   |                           |          |
| <ol style="list-style-type: none"> <li>1. Understanding major concepts of Linear Algebra and Real Analysis.</li> <li>2. To appreciate the criticality of the role of mathematical assumptions in economic modelling.</li> <li>3. To provide foundations of major techniques to solve optimization problems in economics.</li> <li>4. To familiarise students with logical arguments and proofs.</li> </ol>   |  |   |                           |          |
| <b>Course contents</b>   |  |   |                           |          |
| <b>Module</b>  | <b>Topic</b>   | <b>L</b>                                  | <b>T</b>                  | <b>P</b> |
|  | <b>Group 1</b>   |   |                           |          |
| I  | <b>Preliminaries</b><br>(a) Symbolic logic;<br>(b) Necessary vs. sufficient conditions;<br>(c) Methods of proof  | 2   | 0                         | 0        |
|  | <b>Group 2</b>   |   |                           |          |
| II   | <b>Linear Algebra</b><br>(a) Vectors; Vector Spaces; Linear Dependence; Rank and Basis; Inner Product and Norm.<br>(b) Matrices; Basic operations; Rank of a matrix; Inverse of a matrix.<br>(c) Systems of Linear Equations; Existence, uniqueness and calculation of solutions; Determinants; Matrix Inversion; Cramer's Rule.<br>(d) Eigenvalues and Eigenvectors; Relationship with Trace and Determinant; Symmetric matrices; Spectral Decomposition; Quadratic Forms and their Definiteness  | 8   | 3                         | 0        |
|  | <b>Group 3</b>   |   |                           |          |
| III  | <b>Real Analysis</b><br>(a) Real Space;<br>(b) Sequence and Limit; Sequence and Limit in Vector Space;<br>(c) Open Set; Closed Set; Compact Set in Vector Space; Bolzano-Weierstrass Theorem;  | 6   | 3                         | 0        |
| IV   | (d) Continuous functions; Weierstrass' Theorem.<br><b>Differential Calculus</b><br>(a) Single variable case: Slope of a function and its derivative; Continuity and Differentiability; approximation by differential; higher order derivatives.<br>(b) Multiple variables case: Partial derivatives; Total Derivative; higher order derivatives.<br>(c) Vector-valued functions; Jacobian Matrix.<br>(d) Composite functions; Chain Rule. Inverse function and its derivative.<br>(e) Implicit function; Implicit functions of several variables; Systems of Implicit Functions; Solutions of Systems of Implicit Functions: the Implicit Function | 8   | 3                         | 0        |
| V  |  | 4   | 1                         | 0        |

|   |   |    |    |   |
|---|---|----|----|---|
|   | Theorem.<br><b>Convex Analysis</b><br>Convex Sets; Intermediate Value Theorem; Mean Value Theorem; Taylor's Expansion. Concave functions; Concave functions on convex sets; differentiable functions on convex sets and concavity. Quasi-concave functions on convex sets; differentiable functions on convex sets and quasi-concavity.   |    |    |   |
|   | <b>Group 4</b>  |    |    |   |
| VI  | <b>Unconstrained Optimization</b><br>(a) Local and Global maximum; Existence and uniqueness;<br>(b) Necessary and sufficient conditions for local maximum;<br>(c) Necessary and sufficient conditions for global maximum  | 2  | 1  | 0 |
| VII   | <b>Constrained Optimization</b><br>(a) Optimization with equality constraints; Necessary and sufficient conditions for constrained local maximum; sufficient conditions for constrained global maximum.<br>(b) Optimization with inequality constraints; saddle point; constrained global maximum and saddle points; Kuhn-Tucker Conditions and Saddle Points; Sufficient conditions for constrained global maximum; Necessary and sufficient conditions for constrained local maximum. | 8  | 3  | 0 |
| VIII  | <b>Applications</b><br>(a) Linear Programming<br>(b) Integration; differential equations; Optimal Control and Dynamic Programming Problems  | 4  | 0  | 0 |
|   | <b>Total</b>  | 42 | 14 | 0 |
| <b>Evaluation criteria:</b><br><b>Test 1:</b> Homework Assignments: 30%<br><b>Test 2:</b> Written Examination [ Group 2] 20%<br><b>Test 3:</b> Written Examination [Group 3] 30%<br><b>Test 4:</b> Written Examination [Group 4] 20%.   |   |    |    |   |
| <b>Learning outcomes:</b><br>At the end of this course, students will be able to<br>1. Master the essential concepts and techniques of Linear Algebra, Real Analysis and Optimization and apply them to important economic problems [Tests 1-4]<br>2. Understand and appreciate the motivation of essential mathematical assumptions made in economic modelling [Test 4]  |   |    |    |   |
| <b>Pedagogical approach:</b><br>Classroom teaching, interaction and quizzes; tutorials to discuss problem sets and economic applications  |   |    |    |   |
| <b>Materials:</b><br><b>Primary Textbook:</b><br>1. Simon, C.P. and Blume, L., 1994. <i>Mathematics for economists</i> , New York: Norton.<br><b>Additional Textbooks:</b><br>1. Sydsæter, K., Hammond, P., Seierstad, A. and Strom, A., 2008. <i>Further mathematics for economic analysis</i> . Pearson education.<br>2. Sydsæter, K. and Hammond, P., 2008. <i>Essential mathematics for economic analysis</i> . Pearson Education.<br>3. Sundaram, R.K., 1996. <i>A first course in optimization theory</i> . Cambridge university press.<br>4. Vohra, R.V., 2004. <i>Advanced mathematical economics</i> . Routledge.<br>5. Lucas, R.E. and Stokey, N.L., 1989. <i>Recursive methods in dynamic economics</i> , Harvard University Press<br>6. Alpha C. Chiang, 1992. <i>Elements of dynamic optimization</i> . McGraw-Hill.<br><b>Preparatory Textbook:</b><br>1. Chiang, A.C., 1984. <i>Fundamental methods of mathematical economics</i> , McGraw-Hill. |   |    |    |   |
| <b>Additional information (if any):</b><br>Lecture notes and problem sets will be provided.   |   |    |    |   |
| <b>Student responsibilities:</b> Attendance, feedback, discipline: as per university rules.   |   |    |    |   |

**Course reviewers:**

1. Tridip Ray, Professor, Economics and Planning Unit, Indian Statistical Institute, New Delhi
2. Subrata Guha, Associate Professor, Centre for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi

**Prepared by:**

Soumendu Sarkar

|   |   |                          |   |                           |
|---|---|--------------------------|---|---------------------------|
| <b>Course title:</b> Microeconomics   |   |                          |   |                           |
| <b>Course code:</b> MPE 131   |   | <b>No. of credits:</b> 4 | <b>L-T-P:</b> 40-16-0                     | <b>Learning hours:</b> 56 |
| <b>Pre-requisite course code and title (if any):</b> None. However, knowledge of high school calculus is required to follow most of the topics.   |   |                          |   |                           |
| <b>Department:</b> Department of Policy Studies   |   |                          |   |                           |
| <b>Course coordinator:</b> Soumendu Sarkar  |   |                          | <b>Course instructor:</b> Soumendu Sarkar |                           |
| <b>Contact details:</b> soumendu.sarkar@terisas.ac.in   |   |                          |   |                           |
| <b>Course type:</b> Core  |   |                          | <b>Course offered in:</b> Semester 1      |                           |
| <b>Course description:</b><br>Microeconomics is the study of decision-making at the level of the individual or the firm and how it relates to market behaviour. It begins with study of decision-making when markets are competitive, i.e., when individuals cannot influence the market price and there is no information asymmetry. We show that rational decision-making in competitive markets lead to efficient outcomes. Subsequently, we show that markets are no longer efficient when the assumption of competition is withdrawn. We consider three such deviations from competitive markets, viz., monopolistic behaviour, strategic behaviour and asymmetric information, leaving the analysis of public goods and externalities for courses on environment and natural resources. |   |                          |   |                           |
| <b>Course objectives:</b>   |   |                          |   |                           |
| <ol style="list-style-type: none"> <li>1. To introduce students to models of individual and market behaviour at an advanced level of rigour</li> <li>2. To familiarise students with mathematical modelling in Microeconomics</li> <li>3. To emphasize the role of simplifying and critical assumptions in microeconomic modelling</li> </ol>   |   |                          |   |                           |
| <b>Course contents</b>  |   |                          |   |                           |
| <b>Module</b>   | <b>Topic</b>  | <b>L</b>                 | <b>T</b>                                  | <b>P</b>                  |
|   | <b>Group 1</b>  |                          |   |                           |
| I   | <b>Consumer Behaviour</b><br>Preference and utility representation; utility maximisation and expenditure minimisation; duality; market demand; consumer's welfare.  | 6                        | 2   |                           |
| II  | <b>Producer Behaviour</b><br>Technology and its representations; profit maximisation and cost minimisation; duality; market supply.   | 2                        | 2   |                           |
| III   | <b>Competitive Market: Partial equilibrium</b><br>Competitive equilibrium; comparative statics; welfare.  | 4                        | 2   |                           |
| IV  | <b>Competitive Market: General Equilibrium and Pareto Optimality</b><br>Fundamental Theorems of Welfare Economics.  | 4                        | 2   |                           |
| V   | <b>Uncertainty</b><br>Expected Utility Theorem, Measures of Risk Aversion; Insurance; General Equilibrium with uncertainty  | 4                        | 2   |                           |
|   | <b>Group 2</b>  |                          |   |                           |
| VI  | <b>Monopoly</b><br>Monopoly pricing; Price Discrimination; durable goods; Coase conjecture; Product differentiation.  | 4                        | 2   |                           |
| VII   | <b>Strategic Behaviour</b><br>Representation of games; Dominant Strategy; Nash Equilibrium; subgame perfection; repeated games; Applications: Cournot, Bertrand, Stackelberg leadership, Entry deterrence, Rubinstein bargaining.   | 6                        | 2   |                           |
|   | <b>Group 3</b>  |                          |   |                           |
| VIII  | <b>Information and Games of Incomplete Information</b><br>Information Asymmetry and the "Lemons" problem; Adverse selection; Moral Hazard; Games of Incomplete Information and Bayes-Nash equilibrium; Basic Theory of Auctions; Myerson optimal auction; Dynamic Games of Incomplete Information and Perfect Bayesian equilibrium; Spence job market signalling. | 8                        | 2   |                           |
| VIII  | <b>Markets as Institutions</b><br>Transaction cost approach: Coase and Williamson   | 2                        |   |                           |

|  |              |           |           |
|--|--------------|-----------|-----------|
|  | <b>Total</b> | <b>40</b> | <b>16</b> |
| <b>Evaluation criteria:</b>  |              |           |           |
| <b>Test 1:</b> Homework Assignment: 20%  |              |           |           |
| <b>Test 2:</b> Written Examination : Group 1 40%;  |              |           |           |
| <b>Test 3:</b> Written Examination : Group 2: 20%;   |              |           |           |
| <b>Test 4:</b> Written Examination : Group 3: 20%  |              |           |           |
| <b>Learning outcomes:</b>  |              |           |           |
| At the end of this course, students will be able to  |              |           |           |
| 1. Understand standard theoretical models of individual and market behaviour at a rigorous level [Tests 1- 2]                                    |              |           |           |
| 2. Mathematically formulate key microeconomic problems and salient variations [Tests 1, 3, 4]  |              |           |           |
| 3. Critically appreciate microeconomic assumptions and their limitations [Tests 2-4]   |              |           |           |
| <b>Pedagogical approach:</b> Classroom teaching; problem solving sessions (tutorials); interactive sessions.                                     |              |           |           |
| <b>Materials:</b>  |              |           |           |
| <b>Required Texts:</b>   |              |           |           |
| Gibbons, R., 1992. <i>Game theory for applied economists</i> . Princeton University Press.   |              |           |           |
| Jehle, G.A. and P.J. Reny, 2011. <i>Advanced Microeconomic Theory</i> (3 <sup>rd</sup> Edition), Prentice Hall.                                  |              |           |           |
| Mas-Colell, A., Whinston, M.D. and Green, J.R., 1995. <i>Microeconomic theory</i> . New York: Oxford university press.                           |              |           |           |
| Salanié, B., 2005. <i>The economics of contracts: a primer</i> . MIT press.  |              |           |           |
| Tirole, J., 1988. <i>The theory of industrial organization</i> . MIT press.  |              |           |           |
| <b>Required papers:</b>  |              |           |           |
| Coase, R.H., 1937. The nature of the firm. <i>Economica</i> , 4(16), pp.386-405.   |              |           |           |
| Coase, R.H., 1960. The problem of social cost. <i>The journal of Law and Economics</i> , 3(1), pp.1-40.  |              |           |           |
| Williamson, O.E., 2000. The new institutional economics: taking stock, looking ahead. <i>Journal of Economic Literature</i> , 38(3), pp.595-613. |              |           |           |
| <b>Additional information :</b> Lecture notes and problem sets will be provided.   |              |           |           |
| <b>Student responsibilities:</b> Attendance, feedback, discipline: as per university rules.  |              |           |           |

**Course reviewers:**

1. Krishnendu Ghosh Dastidar, Professor, Centre for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi.
2. Manipushpak Mitra, Professor, Economic Research Unit, Indian Statistical Institute, Kolkata.

**Prepared by:**

Soumendu Sarkar



|   |  |                          |                                      |                           |
|---|--|--------------------------|--------------------------------------|---------------------------|
| <b>Course title:</b> Environment and Economic Development   |  |                          |                                      |                           |
| <b>Course code:</b> MPE 142   |  | <b>No. of credits:</b> 4 | <b>L-T-P:</b> 56-0-0                 | <b>Learning hours:</b> 56 |
| <b>Pre-requisite course code and title (if any):</b> MPE 131 Microeconomics and MPE 121 Macroeconomics  |  |                          |                                      |                           |
| <b>Department:</b> Department of Policy Studies   |  |                          |                                      |                           |
| <b>Course coordinator(s):</b> TBD   |  |                          | <b>Course instructor(s):</b> TBD     |                           |
| <b>Contact details:</b> TBA   |  |                          |                                      |                           |
| <b>Course type:</b> Core  |  |                          | <b>Course offered in:</b> Semester 2 |                           |
| <b>Course description</b><br>This course situates the processes of economic growth and development within the larger ecosystem that contains the economic system. In particular it emphasises on the 'source' and 'sink' functions of ecosystem, irrespective of the <i>scale</i> of economic activity. The course links that theory, concepts and method of analysis with the practice--recent developments in the UN System of Environment and Economic Accounting. It begins with the following questions: How does the recognition of ecosystem--economic system linkages, interconnections and exchanges alter the mainstream/historical understanding of development? What are the consequences? Does it get reflected in the making of development policy? If it does, how? If not, why not? At the end of this course, a student is expected to have some answers to these big questions. |  |                          |                                      |                           |
| <b>Course objectives</b>  |  |                          |                                      |                           |
| <ol style="list-style-type: none"> <li>1. To understand the objective, nature, type and constituents of development, underdevelopment, and economic development through an analytical lens</li> <li>2. To locate the multidimensional connections between development, environment, economic development and sustainable economic development</li> <li>3. To comprehend the centrality of ecosystem/environment in both process and outcome of economic growth and development, in both theory and practice</li> <li>4. To appreciate the influences, impacts and interventions in the policy space vis-a-vis economic growth and development due to recognition of contributions of ecosystems in the functioning of economic system.</li> </ol>   |  |                          |                                      |                           |
| <b>Course content</b>   |  |                          |                                      |                           |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>                 | <b>T</b>                             | <b>P</b>                  |
| 1.  | <b>Making and Unmaking of <i>Development</i> and Economic Development</b><br>The objective of this module is to gain familiarity with the phrases, terms and jargons employed in the trajectory of development discourse. The intention is to underscore that it is just not economics that matters in development, but <i>politics, social structure, cooperation, power</i> , etc. This discussion also shows why and how important actors and powerful institutions emerged to attain a set of conflicting goals, more often than not. Two central threads in this module are these questions: <ol style="list-style-type: none"> <li>a. Why the ecology/environment was conspicuously absent in the development discourse till early 1970s?</li> <li>b. In which form the ecology/environment received its recognition since early 1970s and why?</li> </ol>                                       | 10                       |                                      |                           |
| 2.  | <b>Environment and Economic System</b><br>The purpose of this module is to showcase the centrality of the set of ecosystems (that define the environment) in the functioning of economic systems, in particular through the <i>source</i> and <i>sink</i> functions. Various types of resources are analysed in terms of their characteristics and contributions in the economic system, with particular reference to 'well-being' of humans. It also discusses how value systems and valuation processes influences 'value' of a good or a service <i>in economic and sociological terms</i> . This module addresses the following questions: <ol style="list-style-type: none"> <li>a. How economic, social and ecological systems are connected, and to what extent such connections can be captured?</li> <li>b. Does ecosystem services contribute to well-being of all humans, and if</li> </ol> | 8                        |                                      |                           |

|    |   |    |  |  |
|----|---|----|--|--|
|    | not, why not? Is it to do with accessing ecosystem services, or is it the accounting processes involved or <i>incomplete information about the complementarity between ecological entities</i> ?  |    |  |  |
| 3. | <p><b>Environment, Development and Sustainable Development</b></p> <p>This module connects various issues and themes of ‘development’ with environment. It builds on the previous two modules. The objective is to appreciate the impact of recognition of environment in the development discourse in contemporary times. Three approaches are employed here: (a) through the academic plain, in terms of semantics, concepts and meanings of sustainability and sustainable development, (b) by looking through the explicit connections between environment and ‘development’ issues (income-pollution and poverty-environmental degradation) and (c) problematizing the construction and measurement of indicators for sustainable well-being with environment as one of its determinants. The following questions are addressed by this module:</p> <ol style="list-style-type: none"> <li>If the phrase sustainable development does not have a precise and unique meaning, how did and does it influence the development discourse? Which aspects are prioritised and which are neglected?</li> <li>How ecosystem services' contributions to sustainable development are captured?</li> <li>Which environment-development linkages are recognised and explored in the contemporary literature, and in which ways?</li> </ol>   | 8  |  |  |
| 4. | <p><b>Sustainable Economic Development: concepts, theories and principles</b></p> <p>This and the next module are focussed on the most recognised interpretation of sustainable development among the policymakers, namely, sustainable economic development. The reasons are not just a more precise meaning in contrast to other interpretations, but for the sound theoretical grounding, conceptual clarity and sound principles with wide implications on the course of (economic) development.</p> <p>The objective of this module is to understand (a) how various shades of ‘environmentalism’ visualize sustainable economic development (or 'sustainability') and the associated assumptions, along with their implications, (b) various rules and principles that follow the two important variants of environmentalism, namely 'weak' and 'strong' sustainability, and (c) the role that rate of discount plays in these formulations. Following questions are addressed in this module:</p> <ol style="list-style-type: none"> <li>What are the meanings of sustainable economic development, and how do they differ in terms of conceptual frameworks and the associated assumptions? What are the consequences of considering one particular meaning over others? On whom? Which ways?</li> <li>What are the principles behind various constructions of sustainable economic development?</li> <li>What are the possibilities and difficulties in operationalizing various principles embedded in and pathways of sustainable economic development?</li> <li>How does <i>political</i> power play a role in prioritising one meaning of sustainable economic development over the others?</li> </ol> | 10 |  |  |
| 5. | <p><b>Sustainable Economic Development: practices</b></p> <p>This module builds the 'weak' notion of sustainability further. After making the students familiar with the capital theoretic basis of the notion of sustainable (economic) development in the previous module, it takes them to the associated protocols like natural resource accounting, genuine savings, green national income accounting and inclusive wealth. In this module UNESCO MGIEP's simulation based learning game 'Cantor's World' is also employed as a teaching aid to facilitate the understanding of the Inclusive Wealth Index and the uncertainties involved in governing the complex socio-economic system of a</p>  | 12 |  |  |

|  |  |   |  |  |
|--|--|---|--|--|
|  | <p>country. Following questions are addressed in this module:</p> <ol style="list-style-type: none"> <li>What are the assumptions behind the framework adopted for incorporating ecosystem-economic system linkages in accounting frameworks?</li> <li>What do the results of indicators of progress, other than GDP, show in terms of sustainability of economic systems? What are the implications?</li> </ol>   |   |  |  |
| 6.   | <p><b>Environment and Economic Development: the Indian case</b></p> <p>The churning in the cusp of environment and economic development in various international spaces have reached the Indian shores as well--this module discusses few such ripples. Following developments are discussed here:</p> <ol style="list-style-type: none"> <li>Green National Accounts in India: A Framework [Report of the MOSPI Expert Group]</li> <li>The Western Ghats Ecology Expert Panel and High Level Working Group on Western Ghats [conflicts and contestations on environment-development axis through the lens of political economy]</li> </ol> <p>Following questions are addressed in this module:</p> <ol style="list-style-type: none"> <li>What are the steps associated with wealth accounting for natural resources? What are the assumptions that are taken in the process?</li> <li>How stakeholders influence the 'development' pathway-- constrained by environmental concerns, more clearly--to be adopted?</li> </ol> | 8 |  |  |
| <p><b>Evaluation criteria</b></p> <p><b>Test 1: Written test</b> [at the end of teaching of modules 1 and 2] -- <b>20%</b></p> <p><b>Test 2: Submission of a literature survey -- 25%</b></p> <p>Details: Collation and 're-production' of the existing knowledge with marginal additions through a Literature Review of 3500 words (+/- 20%)</p> <ol style="list-style-type: none"> <li>Structure: (1) identification of an important question; (2) explain why it is important for environment and economic development interlinkage (theory and/or policy); (3) how has this question been addressed in the literature; (4) what are the gaps in addressing the question--in scope, method, data or tools.</li> <li>Indicators for assessment: (a) Identification of research problem; (b) Identification of research question(s); (c) Structure and form; (d) Content, language, clarity (Academic Merit); (e) Sincerity.</li> </ol> <p>Note: (d) shall carry a weight of 2x while the rest will carry x each</p> <p><b>Test 3: Written test</b> [at the end of teaching of module 3 and 4] -- <b>20%</b></p> <p><b>Test 4: Written test</b> [at the end of the semester, full syllabus] -- <b>35%</b></p> |  |   |  |  |
| <p><b>Learning outcomes</b></p> <p>By the end of the course, students will:</p> <ul style="list-style-type: none"> <li>command a critical understanding of the key concepts of development, underdevelopment, ecosystem services, sustainable economic development and their uses in practice. [test 1 and 3]</li> <li>be equipped with the 'toolset' for writing a literature survey [test 2]</li> <li>understand the environment-economic development linkages, at the conceptual, theoretical, methodical, policy and operational plains, with illustrations from India.[ test 4]</li> </ul>  |  |   |  |  |
| <p><b>Pedagogical approach</b></p> <ul style="list-style-type: none"> <li>the course doesn't focus on new mathematical tools</li> <li>the course critically investigates the notions of "sustainability", "the economy", "development"</li> <li>key importance of class interactions and discussions</li> </ul> <p>playing a simulation based learning game</p>  |  |   |  |  |
| <p><b>Reading Materials (* = compulsory readings)</b></p> <p><b>Module 1</b></p> <p>*Gilbert Rist, 2008, <i>The History of Development: From Origins to Global Faith</i>, Third Edition, Zed Books</p> <p>Chapter 1: pp. 8-21 [to note: the importance of definition],</p> <p>Chapter 4: pp. 69-79 [what was brought by the pursuit of <i>development</i> and how it changed the policy space],</p> <p>Chapter 5: pp. 80-88 [Bandung Conference and common 'development' policy; and inception of 'Development Agencies'],</p> <p>Chapter 6: pp. 94-99 [Stages of Growth],</p>   |  |   |  |  |

Chapter 7 [Dependency School],

Chapter 8 pp. 123-125, 134-139 [Self-reliance],

Chapter 9, pp. 143-150, 154-157, 162-170 [New International Economic Order, Basic Needs Approach],

Chapter 10, pp. 178-196 [Sustainable Development],

\*Gilbert Rist, 2014, *The History of Development: From Origins to Global Faith*, Fourth Edition, Zed Books

Chapter 14: The Great Turnaround [section on Ecology as a victim of Crisis]

Chapter 15: Beyond 'Development': From Downscaling to a Change in the Economic Paradigm

\*Dag Hammarskjöld project, 1975, *What Now: Another Development*, Dag Hammarskjöld Report of on Development and International Cooperation, *Development Dialogues* 1/2,

part one, pp. 23-43 [development of a non-mainstream framework of 'development' with satisfaction of basic needs and poverty reduction through an endogenous process depending on self-reliance and in harmony with the environment]

ILO, 1976, *Employment, Growth and Basic Needs—a one-world problem*, International Labour Office, Overseas Development Council and International Labour Office, Praeger Publishers, New York and London

Introduction (pp. 1-11) and Chapter 2, Basic Needs (pp. 31-43) [why basic needs approach, and how]

## Module 2

Kenneth E Boulding, 1970, *Economics as a Science*, McGraw-Hill

Economics as an Ecological Science [concept of social entropy]

Economics as a Moral Science [culture, value systems, values]

\*Herman E Daly and Joshua Farley, 2011, *Ecological Economics: principles and applications*, Island Press

Chapter 2: The Fundamental Vision (concepts like optimal scale, throughput, open and closed systems, circular flow, entropy, uneconomic growth, steady state economy)

Chapter 4 The Nature of Resources and the Resources of Nature [stock-flow and fund-service resources, intra- and inter-general rivalry and exclusivity in access/consumption]

Chapter 5 Abiotic Resources (application of concepts from chapter 4 on abiotic resources)

Chapter 6 Biotic Resources (application of concepts from chapter 4 on biotic resources)

Chapter 7 From Empty World to Full World (empirically testing fullness of the world across resources)

\* **MA, 2005, 'Chapter 3: Ecosystems and Human Well-being' in Millennium Ecosystem Assessment, *Ecosystems and Human Well-being: A Framework for Assessment*, Island Press, pp. 71-84**

[what can constitute human well-being; how they are connected with ecosystem services; substitutability among components of well being; trade-off between present and future well-being, both intra- and inter-generational]

Rudolf S de Groot, Matthew A Wilson, Roelof M J Boumans, 2002, 'A typology for the classification, description and valuation of ecosystem functions, goods and services', *Ecological Economics*, 41 (3), pp. 393-408 [a classic paper on the matter of valuation of ecosystem services]

Richard B. Norgaard, Astrid J. Scholz and Sarah Fleisher Trainor, 2001, 'Chapter 6: Values, valuation and valuing processes' in Ekko C. Van Ierland, Jan van der Straaten and Herman Vollebergh, *Economic Growth and Valuation of the Environment*, Edward Elgar [introductory reading on how value systems and accounting processes employed in any valuation influences the value of an ecosystem service]

Stephen C Farber et al, 2002, 'Economic and ecological concepts for valuing ecosystem services', *Ecological Economics*, 41 [connected with the previous paper, it showcases how 'value' of various ecosystem services are constructed]

Herman E. Daly, 'On Economics as a Life Science' *Journal of Political Economy*, 76 (3): 392-406 [this and the next paper together examines the potential and limitations of analysing an ecological system as a mimic of economic system and vice versa]

Robert U Ayres, 2004, 'On the life cycle metaphor: Where ecology and economics diverge', *Ecological Economics* 48(4):425-438

SharachandraLélé and Richard B Norgaard, 1996, 'Sustainability and the Scientist's Burden', *Conservation Biology*, 10(2): 354-365

Erik Gómez-Baggethun, Rudolf de Groot, Pedro L. Lomas and Carlos Montes, 2010, 'The history of ecosystem services in economic theory and practice: From early notions to markets and payment

schemes', *Ecological Economics*, 69: 1209–1218 [from classical days to neoclassical formulation and its limitation in conceiving ecosystem services as a commodity to sustain economic systems] [Advanced]

### Module 3

M V Nadkarni, 2000, 'Poverty, Environment, Development: a many patterned nexus', *Economic and Political Weekly*, April 1

\*SharachchandraLele, 1991, 'Sustainable Development: A critical review', *World Development*[What this phrase means and does not mean]

\*Joseph Stiglitz, Amartya Sen and Jean-Paul Fitoussi, 2010, 'Chapter 3: Sustainable Development and Environment' in *Report by the Commission on the Measurement of Economic Performance and Social Progress*, The New Press [for understanding the matters associated with measurement of 'environment']

\*SoumyanandaDinda, 2004, 'Environmental Kuznets Curve Hypothesis: A Survey', *Ecological Economics*, 49 [a survey of literature on the theoretical, methodical and empirical basis for Environmental Kuznets curve]

\*Partha Dasgupta and Karl-GöranMäler, 1995, 'Chapter 39: Poverty, Institutions, and the Environmental Resource-base' in Hollis Chenery & T.N. Srinivasan (ed.), *Handbook of Development Economics*, volume 3A, Elsevier, pp. 2371-2463 [selected sections]

Part III: Poverty, institutions, and the environment

14. Markets and their failure: Unidirectional and reciprocal externalities

15. Property rights, Coase's theorem, and non-convexities

Mohan Munasinghe, 2001, 'Implementing sustainable development: a practical framework' in Cutler J. Cleveland, David I. Stern, Robert Costanza, eds., *The economics of nature and the nature of economics*, Edward Elgar, pp. 134-192 [selected sections]

David I. Stern, 2001, 'The environmental Kuznets curve: a review', in Cutler J. Cleveland, David I. Stern, Robert Costanza, eds., *The economics of nature and the nature of economics*, Edward Elgar, pp. 193-217

William D. Nordhaus and James Tobin, 1972, 'Is Growth Obsolete?' in *Economic Research: Retrospect and Prospect*, Volume 5, Economic Growth, National Bureau of Economic Research, Chapter URL: <http://www.nber.org/chapters/c7620> [Advanced]

### Module 4

\*Edward B. Barbier, 1987, 'The Concept of Sustainable Economic Development', *Environmental Conservation*, 14 (2), pp. 101-110 [One of the earliest papers on the matter of Sustainable Economic Development]

\*R Kerry Turner, David Pearce and Ian Bateman, 1993, 'Chapter 2: Environment and Ethics' in *Environmental Economics: an elementary introduction*, John Hopkins University Press, Baltimore, pp. 1-40[introduction to varieties of environmentalism]

\*David Pearce, Edward Barbier and Anil Markandya, 1990, 'Chapter 1: Sustainable Development: ecology and economic progress' and 'Chapter 2: Discounting the Future' in *Sustainable Development: economics and environment in the Third World*, Edward Elgar [first chapter is an excellent introduction to the capital theoretic notion of sustainable economic development; second chapter offers a comprehensive overview of matters related to discount rate, including intra- and inter-generational equity]

\*Eric Neumayer, 2013\*, 'Chapter 2: Sustainable Development: conceptual, ethical and paradigmatic issues' in *Weak and Strong Sustainability: exploring the limits of two opposing paradigms*, Fourth Edition, Edward Elgar, pp. 8-48 [to be added]

Herman Daly, 1990, 'Sustainable Development: From Concept and Theory to Operational Principles', *Population and Development Review*, 16, pp. 25-43 [principles and rules]

R Costanza and H Daly, 1992, 'Natural Capital and Sustainable Development', *Conservation Biology*, 6 (1), pp. 37-46 [how ecologists and economics saw the connection]

David W. Pearce and Giles D. Atkinson, 1993, 'Capital theory and the measurement of sustainable development: an indicator of "weak" sustainability', *Ecological Economics*, 8 [the classic paper that differentiated weak from strong sustainability]

K.J. Arrow, W.R. Cline, K. G. Maler, M. Munasinghe, R. Squitieri and J.E. Stiglitz, 1995, 'Intertemporal Equity, Discounting, and Economic Efficiency' in J.J. Houghton, L.G. Meiro Filho, B.A. Callander, N. Harris, A. Kattenberg and K. Maskell, eds., *Climate Change 1995: Economic and Social*

*Dimensions of Climate Change*, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, pp. 129-142.

Kenneth J. Arrow et al, 2014, 'Should Governments Use a Declining Discount Rate in Project Analysis?' *Review of Environmental Economics and Policy*, 8 (2): 145–163

Partha Dasgupta, Stephen Marglin and Amartya Sen, 1972, 'Chapter 1: The Rationale for Social Cost Benefit Analysis' and 'Chapter 13: Intertemporal Choice: the Social Rate of Discount' in *Guidelines for Project Evaluation*, Project Formulation and Evaluation Series no. 2, United Nations, New York [Assumptions and theory behind social rate of discount]

Salah El Serafy, 1989, 'The proper calculation of income from depletable natural resources' in Yusuf J Ahmad, Salah El Serafy, and Ernst Lutz, eds., *Environmental Accounting for Sustainable Development*, Washington, D.C.: World Bank

\*Nick Hanley, Jason F Shogren and Ben White, 2007, 'Chapter 2: The economics of Sustainable Development' in *Environmental Economics: in theory and practice*, Palgrave, pp. 14-41

### Module 5

\*Giovanni Ruta and Kirk Hamilton, 2007, 'The capital approach to sustainability' in Giles Atkinson, Simon Dietz and Eric Neumayer, eds., *Handbook of Sustainable Development*, Edward Elgar, pp. 45-62 [a seminal paper]

\*World Bank, 2006, 'Where is the Wealth of Nations? Measuring Capital for the 21<sup>st</sup> Century', World Bank, Washington DC (Chapters 1-4, 9) [Operationalising the Wealth Accounting]

\*United Nations, 2014, *System of Environmental-Economic Accounting 2012—Central Framework*, Final Version, New York: United Nations, selected sections

Chapter II: Accounting structure [Concepts like environmental assets, stocks and flows, production boundary, economic activity, physical and monetary use tables, asset, functional and economic accounts, economics units, accounting rules and principles, valuation rules and principles]

Chapter V: Asset accounts [selected sections: scope and valuation of environmental assets, principles of asset accounting and illustrations from mineral and energy resources]

Annex A5.1: The net present value method for valuation of stocks and the measurement of depletion and revaluation for natural resources

Annex A5.2: Discount rates

\*UNEP and UNU-IHDP, 2014, 'Chapter 4: Human capital: country estimates using alternative approaches' in *Inclusive Wealth Report 2014: measuring progress toward sustainability*, Cambridge University Press.

Robert Repetto, et al, 1989, 'Chapter 1: The Need for Natural Resource Accounting' in *Wasting Assets: Natural Resource in the National Income Accounts*, World Resources Institute, pp. 1-25 [a classic paper that introduced the notion of natural resource accounting to the world]

Kirk Hamilton and Michael Clemens, 1997, 'Chapter 2: Are We Saving Enough for the Future?' in World Bank, *Expanding the Measure of Wealth Indicators of Environmentally Sustainable Development*, World Bank, Washington DC

Robert Costanza, Steve Farber, Beatriz Castaneda and Monica Grasso, 2001, 'Green national accounting: goals and methods' in Cutler J. Cleveland, David I. Stern, Robert Costanza, eds., *The economics of nature and the nature of economics*, Edward Elgar, pp. 34-56 [selected sections, and table 11.1 in particular]

Joan Martinez-Alier, Giuseppe Munda and John O'Neill, 2001, 'Theories and methods in ecological economics: a tentative classification' in Cutler J. Cleveland, David I. Stern, Robert Costanza, eds., *The economics of nature and the nature of economics*, Edward Elgar, pp. 34-56 [selected sections, and table 2.1 in particular]

Simon Dietz and Eric Neumayer, 2007, Weak and strong sustainability in the SEEA: Concepts and measurement, *Ecological Economics* 6 1: 617 – 626 [application of varieties of environmentalism in SEEA 2003]

Partha Dasgupta and Karl-Göran Mäler, 1995, 'Chapter 39: Poverty, Institutions, and the Environmental Resource-base' in Hollis Chenery & T.N. Srinivasan (ed.), *Handbook of Development Economics*, volume 3A, Elsevier, pp. 2371-2463 [selected sections]

Appendix 2: Net national product in a dynamic economy

### Module 6

\*Government of India, 2013, 'Green National Accounts in India: A Framework', Report of Expert Group [Chair: Partha Dasgupta], National Statistical Organization, Ministry of Statistics and Programme

Implementation, Government of India [Chapter 3-6] [Operationalisation of Greening of GDP and Wealth Accounting in India]

\*Madhav Gadgil *et al.*, 2011, Mapping ecologically sensitive, significant and salient areas of Western Ghats: proposed protocols and methodology, *Current Science*, 100 (2), pp. 175-182 [Applications of rigorous theory and methods in Policymaking]

\*Kanchan Chopra, 2014, 'Conservation and Development in the Western Ghats: A Tale of Two Committees and More', *Economic and Political Weekly*, 59 (11) [Political Economy of Policymaking]

\*Madhav Gadgil, 2014, 'Western Ghats Ecology Expert Panel: A Play in Five Acts', *EPW*, May 3 [commentary on the political economy of policymaking]

\*Kanchan Chopra, 2017, *Development and Environmental Policy in India: The Last Few Decades*, Springer

Chapter 4: Rights-Based Approaches: Do Environmental Movements Make a Dent on Policy?

Chapter 5: Does a Good Knowledge Base Influence Policy-Making [a critical take on stakeholders' influence]

Government of India, 2000, Report of the Committee on Identifying Parameters for Designating Ecologically Sensitive Areas in India [Chair: Pronab Sen], Ministry of Environment & Forests

M. N. Murty and Manoj Panda, 2016, Current Status of Environmental and Economic Accounting: Review of Some Countries Experiences and Way Forward for India, in N Ghosh *et al.*, eds., *Nature, Economy and Society*, Springer and Indian Society for Ecological Economics (INSEE)

Ashish Kothari, 2013, 'Development and Ecological Sustainability in India: possibilities for the post-2015 framework', *EPW*, 48 (30) [Wish list!]

#### **Journals**

*Environmental and Development Economics, Ecological Economics*

#### **Additional information (if any)**

#### **Student responsibilities**

The students are expected to submit assignments in time and come prepared with readings when provided.

#### **Course reviewers:**

Kanchan Chopra, Former Director and Professor, [Institute of Economic Growth](#); University Enclave, North Campus, Delhi, India 110007; Y-155, Regency Park II, DLF Phase IV, Gurugram, Haryana

Gopal Kadekodi; Honorary Professor, [Centre for Multi-Disciplinary Development Research](#), Dr. B.R. Ambedkar Nagar, Near Yalakki Shettar Colony, Dharwad-580004 Karnataka, India;

#### **Prepared by**

Nandan Nawn

| <b>Course title:</b> Probability and Statistics   |  |                          |   |                       |
|---|--|--------------------------|---|-----------------------|
| <b>Course code:</b> MPE 171   |  | <b>No. of credits:</b> 4 |   | <b>L-T-P:</b> 48-0-16 |
| <b>Learning hours:</b> 56   |  |                          |   |                       |
| <b>Pre-requisite course code and title (if any):</b> Statistics and Mathematics courses of BA (Hons) in Economics or equivalent or instructor's consent.  |  |                          |   |                       |
| <b>Department:</b> Department of Policy Studies   |  |                          |   |                       |
| <b>Course coordinator:</b> Seema Sangita  |  |                          | <b>Course instructor:</b> Seema Sangita |                       |
| <b>Contact details:</b> seema.sangita@terisas.ac.in   |  |                          |   |                       |
| <b>Course type:</b> Core  |  |                          | <b>Course offered in:</b> Semester 1    |                       |
| <b>Course description:</b><br>This course introduces the theories of probability and statistics and provides an insight into their applications to economic problems. The course starts with fundamental concepts of probability theory and random variables. This is followed by a discussion of several special families of distributions that are widely used in applications of probability and statistics. The subsequent modules elaborate on sampling, principles of statistical inference, estimators and their properties, etc. Finally, the students are introduced to confidence intervals and hypothesis testing. The students are also introduced to statistical analyses using software such as STATA and R. This course also creates a foundation for introductory and advanced econometrics and research methods. |  |                          |   |                       |
| <b>Course objectives:</b>   |  |                          |   |                       |
| <ol style="list-style-type: none"> <li>1. To provide a foundation of statistical concepts for undertaking data analysis in Economics.</li> <li>2. An exposure to various theories of probability and statistics, listed below, along with a demonstration of their applications.</li> <li>3. To provide hands-on training in the use of statistical softwares for data description, graphical depiction of data, basic probability theory, testing hypotheses, correlation analysis, etc.</li> </ol>  |  |                          |   |                       |
| <b>Course contents</b>  |  |                          |   |                       |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>                 | <b>T</b>                                | <b>P</b>              |
| 1   | <b>Introduction</b><br>Meaning of 'statistics'<br>Data Basics<br>Observational versus Experimental studies<br>Exploratory data analysis<br>Practicals: Starting with STATA/R   | 4                        | 0                                       | 2                     |
| 2   | <b>Probability Theory</b><br>Set Theory<br>Kinds of Probability.<br>Probability-Axiomatic<br>Conditional Probability and Independence<br>Bayes Theorem<br>Practicals: Stata/R based application  | 6                        | 0                                       | 2                     |
| 3   | <b>Random Variable and Distributions</b><br>Random Variables<br>Distribution Functions<br>Density and Mass Functions<br>Distributions of Functions of a Random Variable<br>Expected Values<br>Moments<br>Covariance and Correlation<br>Law of Large Numbers and Central Limit Theorem<br>Practicals: Stata/R based application | 8                        | 0                                       | 2                     |



|  |  |    |   |    |
|--|--|----|---|----|
| 4  | <b>Special Distributions</b><br>Normal distribution<br>Uniform distribution<br>The Binomial and related distributions<br>Poisson distribution<br>Geometric & Hyper-geometric distributions<br>Exponential distribution<br>Gamma<br>Chi-square<br>Beta distributions<br>Practicals: Stata/R based application | 6  | 0 | 4  |
| 5  | <b>Estimation</b><br>Point estimate, interval estimate<br>Properties of estimators – unbiased, consistency, minimum variance, efficiency, sufficiency;<br>Estimation of model parameters – mean, proportion, variance, difference of means, ratio of variances<br>Practicals: Stata/R based application      | 8  | 0 | 2  |
| 6  | <b>Sampling Distributions of Estimators</b><br>Sampling Distribution of a Statistic<br>Sampling from Normal Distribution<br>Confidence Intervals<br>Practicals: Stata/R based application  | 8  | 0 | 2  |
| 7  | <b>Hypothesis Testing</b><br>Introduction to hypothesis testing procedure<br>Simple and composite hypothesis<br>Type I and type II errors and the power function<br>Parametric tests- t-test, $\chi^2$ - test, F-test<br>ANOVA<br>Practicals: Stata/R based application                                      | 8  | 0 | 2  |
|  | <b>Total (in hours)</b>  | 48 | 0 | 16 |
| <b>Evaluation criteria:</b>  |  |    |   |    |
| 1. Test 1 (Modules 1, 2 and 3) 25%   |  |    |   |    |
| 2. Test 2 (Modules 4, 5, 6 and 7) 40%  |  |    |   |    |
| 3. Practical exam (software based) 25%   |  |    |   |    |
| 4. Assignments (Across all modules) 10%  |  |    |   |    |
| <b>Learning outcomes:</b>  |  |    |   |    |
| At the end of this course, students will be able to  |  |    |   |    |
| 1. Understand the fundamental principles of Mathematical Statistics and techniques of proving theorems (Evaluation criteria 1,2 and 4)                           |  |    |   |    |
| 2. Understand the principles, techniques and approaches used for statistical inferences (All evaluation criteria)  |  |    |   |    |
| 3. Apply statistical concepts to economic models(All evaluation criteria)  |  |    |   |    |
| 4. Solve problems of importance using statistical techniques (All evaluation criteria)   |  |    |   |    |
| 5. Use STATA/R for summarising and visualization of data, basic probability theory, testing hypotheses, correlation analysis, etc. (Evaluation criteria 3)       |  |    |   |    |
| <b>Study Materials:</b>  |  |    |   |    |
| Casella, G, and R.L. Berger. 2002. <i>Statistical inference</i> . 2 <sup>nd</sup> Ed., Pacific Grove, Calif: Duxbury.  |  |    |   |    |
| Crawley, M. J. 2014. <i>Statistics: An Introduction Using R</i> . 2 <sup>nd</sup> Ed. Chichester: John Wiley & Sons.   |  |    |   |    |
| Dayal, V. 2015. <i>An Introduction to R for Quantitative Economics</i> , New Delhi: Springer.  |  |    |   |    |
| DeGroot, M. H., and M.J. Schervish. 2012. <i>Probability and Statistics</i> . 4 <sup>th</sup> Ed., Mass: Addison-Wesley.   |  |    |   |    |
| Frain, J. C. 2010. "Introduction to STATA with Econometrics in Mind," <i>Trinity Economics Papers tep0210</i> , Trinity College Dublin, Department of Economics. |  |    |   |    |
| <a href="https://ideas.repec.org/p/tcd/tcduue/tep0210.html">https://ideas.repec.org/p/tcd/tcduue/tep0210.html</a>  |  |    |   |    |
| Mood, A. M., F. A. Graybill, and D. C. Boes. 1974., <i>Introduction to the Theory of Statistics</i> . 3 <sup>rd</sup>  |  |    |   |    |

Ed., New York: McGraw Hill.

**Pedagogical Approach:**

- Classroom teaching, problem solving, quizzes
- Hands-on introduction to software applications

**Additional information:**None**Student responsibilities:** Attendance, feedback, discipline: as per university rules.**Course reviewers:**

1. Prof. Bharat Ramaswamy, Indian Statistical Institute, Delhi Center, 7, S. J. S. Sansanwal Marg, New Delhi, Delhi. 110016.
2. Dr. Sourabh Paul, Indian Institute of Technology Delhi, Hauz Khas, New Delhi.-110 016.

**Prepared by**

Seema Sangita

|   |  |  |                           |           |
|---|--|--|---------------------------|-----------|
| <b>Course Title:</b> Econometrics   |  |  |                           |           |
| <b>Course Code:</b> MPE 172   | <b>No. of credits:</b> 4   | <b>L-T-P:</b> 50-0-12                    | <b>Learning hours:</b> 56 |           |
| <b>Pre-requisite course code and title (if any):</b> MPE 171  |  |  |                           |           |
| <b>Department:</b> Department of Policy Studies   |  |  |                           |           |
| <b>Course coordinator:</b> Kavita Sardana   |  | <b>Course instructor:</b> Kavita Sardana |                           |           |
| <b>Contact details:</b> kavita.sardana@terisas.ac.in  |  |  |                           |           |
| <b>Course type:</b> Core  |  | <b>Course offered in:</b> Semester 2     |                           |           |
| <b>Course description:</b><br>By the end of the semester, the students are expected to be at ease with basic econometric techniques such as setting up a model, testing assumptions and have a critical view on econometric results. Computer classes introduce the student to real life problems and help to understand the theoretical content of the lectures. The course reviews the linear model, ordinary least square regression, hypothesis testing, simultaneity and endogeneity, discrete choice modelling. |  |  |                           |           |
| <b>Course objectives:</b><br>1. To understand classical linear model assumptions, it's violations, and solutions.<br>2. To learn how research problem relating to continuous random variables is formulated, modelled, and analysed through research projects.  |  |  |                           |           |
| <b>Course contents</b>  |  |  |                           |           |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>                                 | <b>T</b>                  | <b>P</b>  |
| 1   | Introduction; The Simple Regression Model                                  | 2  |                           | 2         |
| 2   | Multiple Regression Analysis: Estimation                                   | 4  |                           | 2         |
| 3   | Multiple Regression Analysis: Inference                                    | 4  |                           | 2         |
| 4   | Multiple regression analysis: Further issues                               | 4  |                           |           |
| 5   | Heteroskedasticity, Autocorrelation, Multicollinearity.                    | 6  |                           |           |
| 6   | More on specification and data problems                                    | 4  |                           |           |
| 7   | Multiple regression analysis with qualitative information: Dummy variables | 6  |                           | 2         |
| 8   | Limited dependent variable models.   | 6  |                           | 2         |
| 9   | Simultaneous Equations Models  | 4  |                           | 2         |
| 10  | Instrumental variable estimation   | 4  |                           |           |
| 11  | Introduction to Panel Data   | 4  |                           |           |
| 12  | Conducting and Understanding Empirical Projects                            | 2  |                           |           |
|   | <b>Total</b>   | <b>50</b>                                |                           | <b>12</b> |
| <b>Materials:</b>   |  |  |                           |           |
| <b>Suggested readings</b>   |  |  |                           |           |
| <ul style="list-style-type: none"> <li>Wooldridge, J.M. (2007): <i>Introductory Econometrics: A Modern Approach</i>, Fourth Edition, Thomson South- Western.</li> <li>William H Greene (2003) <i>Econometric Analysis</i>, Pearson Education, 5th edition,</li> </ul>   |  |  |                           |           |
| <b>Modules and reading outline</b>  |  |  |                           |           |
| <b>(Following Wooldridge, 2007)</b>   |  |  |                           |           |
| Module 1: Introduction  |  |  |                           |           |
| <ol style="list-style-type: none"> <li>Empirical economic analysis; economic data; causality</li> <li>Source: Chapter 1</li> </ol>  |  |  |                           |           |
| The simple regression model   |  |  |                           |           |
| <ol style="list-style-type: none"> <li>Definition; derivation of estimators; properties of estimators; goodness-of-fit; units of measurement (data scaling); functional form; regression through the origin</li> <li>Source: Chapter 2, Chapter 6.1, Chapter 6.2</li> </ol>   |  |  |                           |           |
| Module 2: Multiple regression analysis: Estimation  |  |  |                           |           |
| <ol style="list-style-type: none"> <li>Definition and interpretation; properties of estimators; irrelevant variables; omission relevant variable</li> <li>Source: Chapter 3</li> </ol>  |  |  |                           |           |
| OLS asymptotics: large sample properties of OLS estimators: consistency; asymptotic normality   |  |  |                           |           |
| <ol style="list-style-type: none"> <li>Source: Chapter 5</li> </ol>   |  |  |                           |           |
| Module 3: Multiple regression analysis: Inference   |  |  |                           |           |

1. Sampling distribution; testing hypotheses about a single population parameter (one- and two-sided alternatives); confidence intervals; testing hypotheses about a single linear combination of parameters; testing multiple linear restrictions
2. Source: Chapter 4.

Module 4: Multiple regression analysis: Further issues

1. Models with interaction terms; goodness-of-fit; predictions and residual analysis
2. Source: Chapter 6.2 – Chapter 6.4

Module 5: Heteroskedasticity, Autocorrelation, Multicollinearity

1. Consequences; testing for Heteroskedasticity, Autocorrelation, Multicollinearity and remedial measures
2. Source: Chapter 8 and sections from Chapter 11 and 12

Module 6: More on specification and data problems

1. Functional form misspecification; proxy variables; measurement error; missing data; non-random samples; outliers
2. Source: Chapter 9.

Module 7: Multiple regression analysis with qualitative information: Binary (or dummy) variables

1. qualitative information; a single dummy independent variable; dummy variables for multiple categories; dummy variables' interactions; linear probability model
2. Source: Chapter 7.

Module 8: Limited Dependent Variable Models

1. Logit, Probit and Tobit models; Censored and truncated regression models; sample selection corrections
2. Source: Chapter 17.

Module 9: Simultaneous Equations Models

1. Concept of simultaneous equations model. Exogenous and endogenous variables. Predetermined variables.
2. The simultaneous equations bias. Inconsistency of OLS estimators. Structural and reduced forms of the model. Model of demand and supply and simple Keynesian equilibrium model as simultaneous equations models.
3. Identification problem. Rules of identification.
4. Testing exogeneity: Hausman test.
5. Source: Chapter 16

Module 10: Methods of estimation. Indirect Least Squares (ILS).

1. Instrumental Variables. Two-stages Least Squares (TSLS).
2. Source: Chapter 15

Module 11: Introduction to Panel Data

1. Pooling different cross-sections across time; difference-in-difference method; fixed effects and random effects
2. Source: Chapters 13 and 14

Module 12: Conducting and understanding empirical projects

1. Empirical project: framing a question, review of literature, collection of data, empirical analysis, presentation
2. Source: Chapter 19

**Software:** The course places heavy emphasis on using software to analyze data. Software that one mostly works with is STATA.

**Evaluation criteria:**

|                             |  |
|-----------------------------|--|
| Test 1: Written exam        | 20% [Modules 1-6]  |
| Test 2: Practical Exams     | 10% [Modules 1-11; concurrent with written examinations] |
| Test 3: Project             | 20% [Module 12]  |
| Test 4: Written examination | 50% [Modules 7-11]                                       |

**Learning outcomes:**

After completing this course, students will be able to:

1. Identify modelling problems relating to continuous endogenous/choice variables [Tests 1-3]
2. To solve problems relating to continuous endogenous/choice variables through empirical analysis [Tests 2-4]

**Pedagogical Approach:**

- |   |
|---|
| <ul style="list-style-type: none"><li>- Classroom teaching</li><li>- Importance of practicals and software applications</li></ul> |
| <b>Additional Information:</b><br>None  |
| <b>Student responsibilities:</b> Attendance, feedback, discipline: as per university rules.                                       |

**Course reviewers:**

1. SubrataSarkar, Professor, Indira Gandhi Institute of Development Research, Mumbai
2. AbhiroopMukhopadhyay, Associate Professor, Economics and Planning Unit, Indian Statistical Institute, New Delhi

**Prepared by**

Kavita Sardana

|   |   |  |                           |           |
|---|---|--|---------------------------|-----------|
| <b>Course title:</b> Application of Quantitative Data Analysis in Development Practice  |   |  |                           |           |
| <b>Course code:</b>   | <b>No. of credits:</b> 2  | <b>L-T-P:</b> 7-15-12                          | <b>Learning hours:</b> 28 |           |
| <b>Pre-requisite course code and title (if any):</b>  |   |  |                           |           |
| <ul style="list-style-type: none"> <li>• MPD102- Group Practicum: from where students carry their own data sets collected from the field.</li> <li>• MPD111- Quantitative Analysis for Development Practice- from where students are already familiar with basic statistics</li> </ul>  |   |  |                           |           |
| <b>Department:</b> Department of Policy Studies   |   |  |                           |           |
| <b>Course coordinator:</b> Prashant Kumar Singh   |   | <b>Course instructor:</b> Prashant Kumar Singh |                           |           |
| <b>Contact details:</b> <a href="mailto:prashant.singh@terisas.ac.in">prashant.singh@terisas.ac.in</a>  |   |  |                           |           |
| <b>Course type:</b> Optional  |   | <b>Course offered in:</b> Semester 3           |                           |           |
| <b>Course Rationale and Description</b>   |   |  |                           |           |
| <p>The basic premise of this course lies in developing the skill set of students for quantitative data analysis for programme and policy design. MA-SDP students collect enormous amount of data during the course (MPD 102), which is aimed at community needs assessment. While some of this data are analysed by the students using preliminary techniques, many students are interested in gaining a hands-on experience in more advanced techniques. This training can also be useful in applying such techniques on larger datasets such as National Family Health Survey (NFHS), India Human Development Survey (IHDS), National Sample Survey Organisation (NSSO) etc. that are already collected by different agencies and its use in the area of development planning</p> |   |  |                           |           |
| <b>Course objectives</b>  |   |  |                           |           |
| <ul style="list-style-type: none"> <li>▪ To give students training in relatively advanced statistical analysis of primary survey based community level data beyond those covered in pre-requisite courses.</li> <li>▪ To provide hands-on-training on application of relatively advanced statistical analysis to (analyse and interpret)large-scale secondary data</li> </ul>   |   |  |                           |           |
| <b>Course Contents</b>  |   |  |                           |           |
| <b>Module</b>   | <b>Topic</b>  | <b>L</b>                                       | <b>T</b>                  | <b>P</b>  |
| 1.  | <b>Introduction toData Structuring</b><br>Creating database structure, data manoeuvring, transfer (importing and exporting) of data across formats, sorting, filtering and selection of data  | 2  | 5                         | 4         |
| 2.  | <b>Use of Statistical Analysis in Small Sample Surveys</b><br>Application of statistical tools and techniques for small sample size datasets: sample distribution, mean, standard deviations, standard error and confidence interval, tests for mean/proportion, correlation.<br>The tutorial will cover aspects such as: generating variable codes and labels, recoding and merging variables.<br>In the practical session, students will be required to apply the knowledge gained in this and previous modules to structure the data and address problems in the data set, if any. They will be given exposure to common errors in data structuring and analysis. They will be required to undertake exercises related to both structuring and cleaning.   | 2  | 5                         | 4         |
| 3.  | <b>Use of Large Scale Survey in Development Practice</b><br>Linking large scale survey data with sustainability issues including education, health, water and sanitation, gender, socioeconomic and regional differences.<br><br>The tutorial session will focus on understanding salient aspects of large scale surveys (NFHS, IHDS, NSSO): sampling, stratifications, unit of analysis, concept of data hierarchy. It will also include analysis of large scale survey: design effect, bi-variate and tri-variate, regression (simple and multiple regression)<br><br>During the practical session, students will carry out small exercises using these surveys. They will be required to carry out analysis of the data set complete in all respect using appropriate software. Different elements of analysis will be clearly delineated and students will be informed well in advance. | 3  | 5                         | 4         |
|   |   | <b>7</b>                                       | <b>15</b>                 | <b>12</b> |
| <b>Evaluation procedure:</b>  |   |  |                           |           |
| Test 1. Term paper 1: 40% (mid-semester/7 weeks from the beginning)   |   |  |                           |           |
| Test 2. Term paper2: 40% (end of semester/14 weeks from the beginning)  |   |  |                           |           |
| Details: Two separate term papers will be submitted by the students. one will be based on small survey data   |   |  |                           |           |

(carried out by the students during field work for MPD 102); the other will be based on large survey data. Both will have a word limit of 3000-4000.

The guideline on structure and content of the term paper is given below.

(1) Introduction: literature review and existing gaps, need of the study; (2) Methodology: data, dependent and independent variables, methods used, ethical statement; (3) Results: sample distribution, bivariate and multivariate results; (4) Discussion: relevance of study findings in the context of existing knowledge, policy implications, strength and limitations of the study and future direction.

Test 3. Term paper1 based presentation: 10% (mid-semester)

Test 4. Term paper2 based presentation: 10% (end of semester)

#### **Pedagogical approach**

Interactive pedagogical style to maximize the learning opportunity through hands on experience.

Use of statistical package like Stata/SPSS for data processing and analysis.

#### **Learning outcomes**

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

1. Create datasets based on the community based surveys for statistical analysis: First term paper preparation enables student to construct their own datasets (Test 1 and 3).
2. Use appropriate statistical approach depending on the nature of data: Application of appropriate statistical techniques will be assessed based on the term paper evaluation where students will be asked to apply suitable statistical technique based on nature of variables and number of samples (Test 2 and 4).
3. Use large scale survey in different development context ranging from problem identification to programme and policy design: The second term paper will be based on current development challenges and how large scale nationally representative surveys can be used to generate evidence and evaluate policies (Test 2 and 4).

#### **Reading lists**

IBM SPSS. *Statistics 22 Core System User's Guide*.

[http://www.sussex.ac.uk/its/pdfs/SPSS\\_Core\\_System\\_User\\_Guide\\_22.pdf](http://www.sussex.ac.uk/its/pdfs/SPSS_Core_System_User_Guide_22.pdf)

International Institute for Population Sciences (IIPS) and ICF. 2017. *National Family Health Survey (NFHS-4), 2015-16: India*. Mumbai: IIPS. <http://rchiips.org/nfhs/NFHS-4Reports/India.pdf>

Ministry of Statistics and Programme Implementation, Government of India. *National Sample Survey*.

<http://www.mospi.gov.in/national-sample-survey-office-nssso>

National Council of Applied Economic Research and University of Maryland. *India Human Development Survey (IHDS), 2005. 2017*. doi:10.3886/ICPSR22626.v11 <https://ihds.umd.edu/>

StataCorp. 2017. *Stata: Release 15*. Statistical Software. College Station, TX: StataCorp

LLC. <https://www.stata.com/manuals/r.pdf>

#### **Additional information (if any)**

#### **Student responsibilities**

Attendance, feedback, timely assignment/project submission as per the University rule.

#### **Course Reviewers:**

Dr. Manoj Alagarajan, Department of Development Studies, International Institute for Population Sciences (IIPS), Mumbai.

Dr. Akhilesh Kr. Sharma, Institute for Human Development, New Delhi.

#### **Prepared by:**

Prashant Kumar Singh

| <b>Course title:</b> Art and Sustainability   |  |   |                           |   |
|---|--|---|---------------------------|---|
| <b>Course code:</b> DPS XYZ   | <b>No. of credits:</b> 2   | <b>L-T-P:</b> 7 -11- 20                     | <b>Learning hours:</b> 28 |   |
| <b>Pre-requisite course code and title (if any):</b> Nil  |  |   |                           |   |
| <b>Department:</b> Department of Policy Studies   |  |   |                           |   |
| <b>Course coordinator:</b> Anandajit Goswami  |  | <b>Course instructor:</b> Anandajit Goswami |                           |   |
| <b>Contact details:</b> <a href="mailto:anandajit.goswami@terisas.ac.in">anandajit.goswami@terisas.ac.in</a>  |  |   |                           |   |
| <b>Course type:</b> Optional  |  | <b>Course offered in:</b> Semester 2        |                           |   |
| <b>Course Description and Rationale:</b>  |  |   |                           |   |
| <p>This course is geared towards sensitizing students on different dimensions of sustainability by creating varying art forms through the core philosophical principles of introspection, reflection, action and liberation. While applying the four core principles of introspection, reflection, action and liberation, this course will delve into a liberating journey from the bonded sense of materialism by integrating notions of sustainability, efficiency and sufficiency while connecting with notions of human welfare and quality of life. This integration will be achieved through art forms like painting, music, dance, theatre and literary forms capturing the economic, social and ecological dimensions of sustainability. These art forms will be created by the student facilitated by a liberating journey through the action of art form creation, curated by the course coordinator. The course attempts to enable such an action after the first two core philosophical foundation principles of introspection and reflection are initiated.</p> <p>The course aims to develop a capacity of introspection and self-reflection among the students through the creation of art forms in order to inform, engage and motivate the humanity on ecological, social and economic dimensions of sustainability. Understanding of the trajectories of South Asian/Eastern and Western traditions of art forms and its varying applications with a practitioners' experimental perspective will be used as one of the methods in this course.</p> |  |   |                           |   |
| <b>Course objectives:</b>   |  |   |                           |   |
| <p>The main objective of this course is to sensitize future sustainability professionals who can -</p> <ul style="list-style-type: none"> <li>▪ Appreciate the need for creating a self-driven and introspective, reflective, liberating journey towards understanding the economic, social and ecological domains of sustainability in their professional and public life.</li> <li>▪ Understand the definition of art, varying traditions of art and art forms from a historical perspective and the different principles, trajectories of art forms which can be applied in finding out solutions for making policies addressing sustainability challenges in professional domains</li> <li>▪ Create a bridge and integration between sustainability, efficiency and sufficiency principles of human welfare in a materialism driven society</li> <li>▪ Create a bridge between theory, principles and practices of sustainability in their professional life to offer solutions to sustainability challenges</li> </ul>   |  |   |                           |   |
| <b>Course content:</b>  |  |   |                           |   |
| Module  | Topic  | L   | T                         | P |
| 1.  | <p><b>Introduction to art and art forms for sustainability</b></p> <p>The module will be helpful in establishing the basis for self-reflection as a practice to address the objectives of this course. In this module, trajectory of art forms from selected spatio-temporal spaces will be studied for understanding alternative approaches to sustainability. In this the following questions will be addressed:</p> <ol style="list-style-type: none"> <li>a) What is an art, an art form and traditions of art?</li> <li>b) How the Indian and Western traditions differ?</li> <li>c) How the trajectory of art and art forms can aid in reflecting on different dimensions of sustainability?</li> </ol>  | 2   |                           |   |
| 2.  | <p><b>Reflection on Art for Sustainability: An Overview</b></p> <p>This module will help the student to create a <i>bridge</i> between the theories, principles and practices of sustainability on the one hand and art forms on the other. It will address the following questions:</p> <ol style="list-style-type: none"> <li>a) What are the methods, principles and practices of art forms that have been <i>experimented</i> with to capture the dimensions of sustainability in both South Asian/Eastern and Western traditions?</li> <li>b) How does the <i>embeddedness</i> of nature and society vary in the South Asian/Eastern and Western traditions on the one hand and across time in both the traditions?</li> <li>c) What are the possible reasons behind such variances?</li> </ol> | 2   | 3                         |   |



|  |   |   |    |    |
|--|---|---|----|----|
| 3.   | <p><b>Actioning Art for Sustainability</b><br/>Building on the previous two modules, this one will be on the practice. It will demand self- reflective action on the part of the student to <i>create</i> the bridge, which will be established through the art forms created by each student (later in the course). The questions which will be addressed through this module are as follows:</p> <p>a) What are the forms through which the action(s) can be executed by a student to reflect on any or multiple dimensions of sustainability? [details in pedagogical approach below]</p> <p>b) How can a student locate or identify the <i>most</i> suitable form of action?</p>  | 2 | 2  |    |
| 4.   | <p><b>Liberating Art for Sustainability</b><br/>In this module the student is required to <i>create</i> a work following the reflection and action carried out in previous modules. In this module, the students will explore the following question: How can an individual liberate her/himself from the bonds that one has, such as materialism, through a self-creation of art form?</p> <p>Students can pick up any theme within the domain of sustainability, including and not limited to as, equity or justice or low cost technological options imbibing art and can create the art form accordingly. [Example: Against the theme of equity or justice one can choose issues of tribal rights, livelihood marginalization, changing rural and city landscapes].</p> <p><u>Practicals</u><br/>Here the task before every student is to create and submit through any of the forms below:</p> <ul style="list-style-type: none"> <li>• A short story, poetry, any literary output submission (A soft copy submission)</li> <li>• A painting/sketch/sculpture/clay art submission (through visual print outs of the creation with a proof that the student has created it)</li> <li>• A short documentary submission (in a 5 minute video)</li> <li>• A music composition submission (through a 4 minute audio/video production)</li> <li>• A theatre or dance form submission (as a group or solo act with a video submission)</li> <li>• Any other art form which any particular student wants to submit</li> <li>• A critical review of any book (with principles of reflection, action and liberation and centering around the domains of sustainability) (through a short 1000 word write up)</li> </ul> <p>Each creation has to describe how the principle philosophies of the course viz. introspection, reflection, action and liberation are embedded in the art form. Length of the description cannot exceed 500 words.</p> | 1 | 2  | 20 |
| <b>Total</b>   |   | 7 | 11 | 20 |
| <p><b>Evaluation criteria</b></p> <ul style="list-style-type: none"> <li>▪ <b>Test 1:</b> A Critical Analysis of a self chosen book: 40% weightage<br/>[Evaluation criteria: the student with more original, out of the box thinking and perspectives will be graded higher]</li> <li>▪ <b>Test 2:</b> Art form (short story, poetry, any type of literary output, painting, short documentary, dance video, music composition, any other art form according to the interest of the student): 40% weightage<br/>[All submissions will be displayed on the campus and will be subjected to an online voting by faculty members and students in this course .</li> <li>▪ <b>Test 3:</b> Class Room Participation: 20% weightage. It will be based on the contribution by group of students in the discussion in the class. 5 groups will be created and a question related to certain themes surrounding sustainability will be posed before them. Member of each group will discuss among themselves before presenting their arguments. Evaluation criteria: establishing co-creation of knowledge and it's expression. All members in a given group will receive identical marks.</li> </ul> |   |   |    |    |
| <p><b>Learning outcomes</b><br/>After attending this course, a group of future students and sustainability professionals will be created who will –</p> <ul style="list-style-type: none"> <li>• Have the ability to create and sustain an introspective, self – reflective (<b>Test 1&amp; 3</b>), empathetic (<b>Test 2</b>), experimental perspective (<b>Test 2</b>) about bridging, integrating philosophies between the theoretical, experimental and practical aspects of social, economic and environmental domains of sustainability</li> <li>• Will be able to create application of different art forms in their professional and public life with four main components viz. introspection, reflection, action and liberation (<b>Test 2</b>)</li> <li>• Will be able to create a collective, integrated thinking around issues and principles of equity and justice</li> </ul>   |   |   |    |    |

surrounding sustainability by using different art forms (**Test 3**)

### **Pedagogical approach**

Classroom discussions, open debates and questioning of conventional approaches of sustainability through art forms in order to create a philosophical bridge between theory, principles and practices of sustainability will be a key component.

An experimental mode of approaching the issues of sustainability through self learning and art form experimentation to generate new sustainability products for the society will be the other. This will be introduced to enable the students to reflect, create, act and then liberate themselves to observe, express sustainability domains in newer ways and forms. The course will also motivate and inspire students towards:

- Picking up streams of art – music, dance, sound, literature, films, etc. and examples from them for case study analysis to discuss how sustainability is analyzed and explored through these case studies. The case studies will help in understanding the experimental modes of art forms for reflecting on the social, economic and environmental domains of sustainability.
- Interactions with “A Sustainability Experimentalist” from any art field
- Interactions with a noted musician, writer, singer or any performer/sustainability experimentalist through classroom interaction
- Picking up of any relevant book focusing on the core principles of reflection, action and liberation component of sustainability
- Critical book review with a focus on reflection, action and liberation component of sustainability
- Original Unique Interpretation of Certain Artefacts and its implication for sustainability (by every student) based on the understanding from the reading materials for the course
- Reinterpretation of sustainability issues (any issues – social, economic, environmental and ecological) through an original short story/critical review submission of any vernacular/national/international existing book (with principles of reflection, action and liberation and centering around the domains of sustainability) which the student wants to opt for
- In the practical segment of the course , each student will have to pick up any art stream like short story, poetry, any literary output, painting/sculpture/sketch/clay art (through visual print outs of the creation with a proof that the student has created it), short documentary (in a 5 minute video), music composition or production (through a 4 minute audio/video production), maximum 10 minute theatre production (as a group or solo act with a video submission), photography (through visual print outs) and submit it for display all across the university for open online voting. Each of the creation has to describe how the principle philosophies of the course viz. introspection, reflection, action and liberation are coming out of the art form by imbibing the different principles of sustainability. For every art form creation that description has to be given succinctly by each student in 500 words.

### **Materials** (\*= compulsory readings)

#### **Module 1:**

\* N. Blanc, & B. L. Benish (2016) *Form, Art and the Environment: Engaging in Sustainability*. Taylor & Francis.

- Part 2: Chapter 3- Alternative Paths to Sustainable Development via the Arts
- Part 3. Chapter 3 - Framing activity, process and experience as art
- Part 6. Chapter 6 - Making New Local Economic Cycles
- Part 7. Chapter 7 - Creative Individuals: Local Production, Lifestyle and Robinson Caruso
- Part 8. Chapter 8 - Artists as Scientists, Macro to Micro

\* M. Pointon (2014) *History of art: a student's handbook*. Routledge.

- Chapter 1: Engaging with Art
- Chapter 2: How art historians work: training and practice
- Chapter 3: Art History as a Discipline
- Chapter 6: And what are you going to do now?

Sacha Kagan (2011) *Art and Sustainability: Connecting Patterns for a Culture of Complexity*, Transcript-Verlag

#### **Module 2:**

\* Desai, D., Hamlin, J., & Mattson, R. (2009). *History as art, art as history: Contemporary art and social studies education*. Routledge.

- Chapter 2: Using Visual Historical Methods
- Chapter 4: Artists in the realm of historical methods

Glen Coutts and Timo Jokela (2010) eds. *Art, Community and Environment: Educational Perspectives*, Intellect Ltd

#### **Module 3 & 4**

\* Desai, D., Hamlin, J., & Mattson, R. (2009). *History as art, art as history: Contemporary art and social studies education*. Routledge.

- Chapter 6 – Introduction to teaching toolkits: Visual Approaches to teaching about history
- Chapter 3 – Curriculum as a creative process

C. Spretnak (2014) *The Spiritual dynamic in modern art: art history reconsidered, 1800 to the present*. Springer.

### **Suggested Readings:**

Sarnath Banerjee (2005) *Corridor: A Graphic Novel*, Penguin Books

Anandajit Goswami (2017) *Lucy and The Train: Tryst with Sustainability*, TERI Press

**Student responsibilities**

The students are expected to submit book review/critical analysis article, sustainability products of their choices on time and should freely ask unconventional questions in the class and seek for solutions to those questions in their sustainability products.

**Course Reviewer**

1. Dipankar Gupta, Retired Professor, Jawaharlal Nehru University
2. Sreedeeep Bhattacharya, Fellow, Shiv Nadar University
3. Avijit Chakraborty, Visiting Faculty, Ambedkar University

**Prepared By**

Anandajit Goswami

**Course syllabus for Semester I**

| <b>Course title:</b> Principles of Cartography  |   |                          |  |                           |
|---|---|--------------------------|--|---------------------------|
| <b>Course code:</b> NRG 171   |   | <b>No. of credits:</b> 3 | <b>L-T-P:</b> 20-8-28                        | <b>Learning hours:</b> 42 |
| <b>Pre-requisite course code and title (if any):</b> None   |   |                          |  |                           |
| <b>Department:</b> Department of Natural Resources  |   |                          |  |                           |
| <b>Course coordinator:</b> Dr Anu Rani Sharma   |   |                          | <b>Course instructor:</b> Dr Anu Rani Sharma |                           |
| <b>Contact details:</b>   |   |                          |  |                           |
| <b>Course type:</b> Core  |   |                          | <b>Course offered in:</b> Semester 1         |                           |
| <b>Course Description</b><br>In this course, we study the art, science, politics, and technologies of cartography, to understand how maps are created and used to represent and communicate spatial phenomena and their relationships. Course lectures, readings, discussions and lab activities will introduce to the concepts, techniques, hardware, and software used for cartography. |   |                          |  |                           |
| <b>Course objectives</b><br>1. To apply principles of map preparation techniques<br>2. To use different thematic mapping techniques to represent spatial phenomena<br>3. To design maps for effective communication   |   |                          |  |                           |
| <b>Course content</b>   |   |                          |  |                           |
| SNo   | Topic   | L                        | T  | P                         |
| 1   | <b>Introduction to Maps</b><br>History of Map making, Basic characters of Map, Type of maps, Cartographic databases   | 2                        |  |                           |
| 2   | <b>Map direction and Scale</b><br>Fundamentals of Map direction & scale; Construction of different types of scales  | 2                        | 2  |                           |
| 3   | <b>Details of Datum, Geodetics and Spheroid</b><br>Basic assumptions, Coordinate System: Polar and Cartesian, Geodesy and Geodetic methods, datum types and elements,   | 4                        |  |                           |
| 4   | <b>Concept of Map Projections</b><br>Map projections-Conic projection, Cylindrical projection, Zenithal Projection; Comparison between these projection, Choosing a Map Projection<br>Mercator, Transverse Mercator, Polyconic, Lambert, Orthographic and UTM | 2                        | 2  |                           |
| 5   | <b>Map Preparation Techniques and Map accuracy</b><br>Map Preparation Techniques: Cartographic design issues, Map design process and compilation  | 2                        | 2  |                           |
| 6   | <b>Modern Techniques in Cartography and Computers</b><br>Generalization, Symbolization, Multivariate and dynamic mapping, Modern techniques in Cartography  | 2                        |  |                           |
| 7   | <b>Cartography and GIS</b><br>Synergy of Cartography and GIS  | 2                        |  |                           |
| 8   | Introduction to perception, visualization, topographic and thematic mapping and color coding  | 2                        |  |                           |
| 9   | <b>Evaluation Criteria</b><br>Evaluation criteria for maps, Map evaluation guidelines   | 2                        | 2  |                           |
| PRACTICALS  |   |                          |  |                           |
| 1   | <b>Topographical sheets</b><br>Topographical Sheets: Introduction/comparison with respect to types, scales, grid reference, signs and symbols and colour schemes of SOI   |                          |  | 8                         |

|   |   |           |          |           |
|---|---|-----------|----------|-----------|
|   | <b>Topographical map interpretation</b><br>Study and interpretation of Indian topographical maps of survey of India (Series - 1: 50000 or 1: 25000) |           |          |           |
|   | <b>Base map and thematic map generation</b>   |           |          |           |
| 2   | Construction of different type of scale   |           |          | 2         |
| 3   | Construction of Map projections   |           |          | 4         |
| 4   | Analog to digital conversion  |           |          | 2         |
| 5   | Map preparation techniques  |           |          | 2         |
| 6   | Map designing and Symbolization   |           |          | 4         |
| 7   | Map evaluation  |           |          | 2         |
| 8   | Geoprocessing tools   |           |          | 4         |
|   | <b>Total</b>  | <b>20</b> | <b>8</b> | <b>28</b> |
| <b>Evaluation criteria</b>  |   |           |          |           |
| <ul style="list-style-type: none"> <li>▪ Test1 [Written Exam]: 10%</li> <li>▪ Test2 [Written Exam]: 10%</li> <li>▪ Tutorials and assignments: 20%</li> <li>▪ Practical (Lab exercise and viva) (Practical is conducted at the end of the semester and includes evaluation of the lab exercises student carried out throughout the semester: 20%)</li> <li>▪ Test 3 (Test 3 is conducted after completion of the course, at the end of the semester): 40%</li> </ul> |   |           |          |           |
| <b>Learning outcomes</b>  |   |           |          |           |
| Upon completion of the course, student will be able to:   |   |           |          |           |
| 1. Design and Geovisualize maps and communicate in perspective [Test1, test2, Tutorials and Assignments, Practical]   |   |           |          |           |
| 2. Critically analyze a map to understand its scientific, social and political utility [Test1, Test2, Tutorials and Assignments, Practical, Test3]  |   |           |          |           |
| <b>Pedagogical approach</b>   |   |           |          |           |
| The course will be delivered through class lectures, lab exercise and tutorials.  |   |           |          |           |
| <b>Materials</b>  |   |           |          |           |
| Required text   |   |           |          |           |
| 1. Robinson A. H., Morrison J. L., Muehrcke P. C., Kimerling A. J., Guptill S. C. (1995) Elements of Cartography: Wiley Publishers  |   |           |          |           |
| 2. MacEachren A.M. (1994) Some Truth with Maps: A Primer on Symbolization and Design, University Park: The Pennsylvania State University.   |   |           |          |           |
| 3. Mishra R.P. (2014) Fundamentals of Cartography, Concept Publishing Co.   |   |           |          |           |
| 4. Monmonier M. (1991) How to Lie with Maps, Chicago: University of Chicago Press.  |   |           |          |           |
| Suggested readings  |   |           |          |           |
| 5. Monmonier M. (1993) Mapping It Out, Chicago: University of Chicago Press.  |   |           |          |           |
| 6. Pickles J. (2003) A History of Spaces: Cartographic Reason, Mapping and the Geo-Coded World, Taylor & Francis.   |   |           |          |           |
| 7. Sircar D.C.C. (1990) Studies in the Geography of Ancient and Medieval India, Motilal Banarsidass Publishers.   |   |           |          |           |
| 8. Slocum T. (2003) Thematic Cartography and Geographic Visualization, Upper Saddle River, New Jersey: Prentice Hall.   |   |           |          |           |
| 9. Wilford J.N. (2000) The Mapmakers, Vintage Books.  |   |           |          |           |
| Journals  |   |           |          |           |
| 1. Asian Journal of Geoinformatics  |   |           |          |           |
| 2. Cartographic Journal   |   |           |          |           |
| 3. Geocarto International   |   |           |          |           |
| 4. International Journal of Geoinformatics  |   |           |          |           |
| 5. International Journal of Remote Sensing  |   |           |          |           |
| 6. ISPRS Journal of Photogrammetry and Remote Sensing   |   |           |          |           |
| 7. Journal of Historical Geography  |   |           |          |           |
| 8. Journal of Indian Society of Remote Sensing  |   |           |          |           |

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|--|
| Remote Sensing of Environment  |
| <b>Additional information (if any)</b><br><b><u>Magazines</u></b><br>1. Coordinates<br>2. Geospatial today<br>3. GIM International<br>4. GIS World<br>5. GIS@development<br>1. GPS World |
| <b>Student responsibilities</b><br>Attendance, feedback, discipline, guest faculty etc.  |

**Course Reviewers:**

1. Prof. J. K. Garg, Guru Gobind Indraprastha University
2. Dr. Benidhar Deshmukh, IGNOU

| <b>Course title:</b> Principles of GIS and GNSS  |  |                          |  |                           |
|--|--|--------------------------|--|---------------------------|
| <b>Course code:</b> NRG 175  |  | <b>No. of credits:</b> 4 | <b>L-T-P:</b> 38-2-32                    | <b>Learning hours:</b> 56 |
| <b>Pre-requisite course code and title (if any):</b> None  |  |                          |  |                           |
| <b>Department:</b> Department of Natural Resources   |  |                          |  |                           |
| <b>Course coordinator:</b> Dr Vinay Sinha  |  |                          | <b>Course instructor:</b> Dr Vinay Sinha |                           |
| <b>Contact details:</b>  |  |                          |  |                           |
| <b>Course type:</b> Core   |  |                          | <b>Course offered in:</b> Semester 1     |                           |
| <b>Course Description</b><br>It introduces participant to the fundamentals of GIS, GNSS, data models, data sources, databases, cartography, Overview of Global Navigation Satellite System (GNSS) and geospatial metadata. |  |                          |  |                           |
| <b>Course objectives</b>   |  |                          |  |                           |
| 1. To provide a firm understanding of the conceptual and technical understanding of GIS and GNSS   |  |                          |  |                           |
| 2. To prepare students for spatial data analysis and modelling   |  |                          |  |                           |
| <b>Course content</b>  |  |                          |  |                           |
| Th#  | Topic  | L                        | T  | P                         |
| 1  | Basic concepts about spatial information: Philosophy, brief history and definition of GIS, Computer Aided Cartography Vs GIS, Manual mapping Vs GIS mapping  | 2                        |  |                           |
| 2  | Geometrical feature and real word Pictures, Variables- Points, Lines and Areas and applications of GIS in various sectors (a case study approach)  | 2                        |  |                           |
| 3  | Basic Objectives and Components of GIS – details of hardware, software and management; Conceptual models of Real world phenomena.  | 2                        |  |                           |
| 4  | Introduction to GIS software; Overview of open source GIS Mercator, Polyconic, Lambert, Orthographic and UTM   |                          | 2  |                           |
| 5  | Information organization and data structure; Basic file structures, Tabular databases and Advantages of databases  | 2                        |  |                           |
| 6  | Spatial and Non-spatial data base, Spatial data model: Geo relational Vector data model, Object based vector data model, Geodatabase   | 2                        |  |                           |
| 7  | Raster data model; Hybrid relational database Vs Object orientation. Comparative analysis of spatial database  | 2                        |  |                           |
| 8  | GIS data Requirement, various sources, Standards and collection of GIS data, Methods of data capture: scanning, digitization and associated errors; Conversion from other digital Sources, Attribute data input and management | 2                        |  |                           |
| 9  | Different kinds of geospatial data, Sources of errors in GIS database: Errors through processing, Errors associated with overlay issues of features, Detecting and evaluating errors, Edge matching                            | 2                        |  |                           |
| 10   | Introduction of Global Navigation Satellite System, Satellite constellation & Segments (Control, Space & User) GNSS signals and data, Geopositioning – Basic concepts (GPS, NAVSTAR, GLONASS and IRNSS /NAVIK)                 | 2                        |  |                           |
| 11   | Introduction to Hand held GPS receivers; Initial setting & Creating codes and attribute table in receiver  |                          |  |                           |
| 12   | GNSS Positioning Types-Absolute positioning, Differential positioning  | 2                        |  |                           |
| 13   | GNSS performance and policy (Accuracy, integrity, SPS, PPS DoD & DoT policy, anti-spoof); Positioning Errors: Multi path, Ionosphere, Troposphere, Satellite Geometry, Satellite signals and its strength,                     | 2                        |  |                           |
| 14   | Introduction to DGPS, wide area augmentation system (WAAS)   | 2                        |  |                           |
| 15   | Nature of geographic data-Types of uncertainty in a GIS; Data quality parameters: Positional accuracy, Attribute accuracy, Logical consistency, Completeness lineage,  | 2                        |  |                           |

|       |   |           |          |           |
|-------|---|-----------|----------|-----------|
| 16    | Topological relationships; Creation of topology and error correction;   | 2         |          |           |
| 17    | Attribute data query, SQL, Logical, Boolean, Arithmetical operation and function,   | 2         |          |           |
| 18    | Feature base operation – buffer, eliminate, dissolve  | 2         |          |           |
| 19    | Layer based overlay analysis: point to polygon, line to polygon, clip, erase, split, identity, union and intersection, Distance measurement | 3         |          |           |
| 20    | Raster data structure, Local operations, Neighbourhood operations, Zonal operations   | 3         |          |           |
| Exp # | <b>PRACTICALS</b>   |           |          |           |
| 1     | Lab 1. Analog to Digital conversion -Scanning methods   |           |          | 2         |
| 2     | Lab 2. Introduction to software   |           |          | 2         |
| 3     | Lab 3 Map Rectification, Define projection and Reprojection.  |           |          | 2         |
| 4     | Lab4: Vector Transformation – Affine and Polynomial, co-ordinate definition. Map Bound.   |           |          | 2         |
| 5     | Lab 5. Digital database creation -Point features, Line features, Polygon features   |           |          | 2         |
| 6     | Lab 6. Data editing-Removal of errors -Overshoot & Undershoot, Snapping, Topology Creation  |           |          | 2         |
| 7     | Lab 7. Data collection and Integration, Non-spatial data attachment working with tables   |           |          | 2         |
| 8     | Lab 15. Introduction to GPS receiver and initial setting & Creating codes and attribute table in receiver                                   |           |          | 2         |
| 9     | Lab 16. Point data collection using GPS with different datum  |           |          | 2         |
| 10    | Lab 17. Point / Line / Area data collection using GPS and measurements  |           |          | 2         |
| 11    | Lab 18. GPS data collection in DGPS mode  |           |          | 2         |
| 12    | Lab 19. Post processing of the GPS data   |           |          | 2         |
| 13    | Lab 20. Image rectification using GPS coordinate data   |           |          | 2         |
| 14    | Lab 8. Dissolving and Merging   |           |          | 2         |
| 15    | Lab 9. Clipping, Intersection and Union   |           |          | 2         |
| 16    | Lab 10. Proximity Analysis  |           |          | 2         |
| 17    | Lab 11. Spatial and Attribute query and Analysis  |           |          | 2         |
| 18    | Lab12. Creation of Blank Grid/Raster  |           |          | 2         |
| 19    | Lab13. Map algebra / Math in Raster data  |           |          |           |
| 20    | Lab 14. Layout generation and report  |           |          | 2         |
|       | <b>Total</b>  | <b>38</b> | <b>2</b> | <b>32</b> |

#### **Evaluation criteria**

- Test 1: Written test [at the end of Th# 9 and Exp# 7] 10%
- Test 2: Written test [at the end of Th# 14 and Exp# No 13] 10%
- Practical: Laboratory + Written test [at the end of practical, full experiment 1-20] -- 40%
- Test 4: Written test [at the end of the semester, full syllabus] -- 40%

#### **Learning outcomes**

Upon completion of this course, student will be able to:

1. Create and understand database in spatial platform for analysis and modeling for various applications [test -1]
2. Conduct the GNSS based survey and mapping under variety of planning and management applications [test-2]
3. Capable to understand the use of spatial tools & techniques for analysis and modeling of the spatial data over various natural and human resource mapping, monitoring and management [Practical and test-3]

**Pedagogical approach:** The course will be delivered through class lectures, lab exercise and tutorials.

#### **Materials**

Required text

1. Burrough P.A. and McDonnell R.A. (1998) Principles of Geographical Information Systems, Oxford University Press, Oxford,
2. Chang K. (2007) Introduction to Geographic Information System, 4th Edition, McGraw Hill.



3. Lo C. P and Yeung A. K. W. (2009) Concepts and Techniques of Geographic Information Systems, 2<sup>nd</sup> Edition, New Jersey, Pearson Prentice Hall
4. Verbyla D. L. (2002) Practical GIS Analysis, London and New York, Taylor and Francis.
5. Berry J.K. (1993) Beyond Mapping: Concepts, Algorithms and Issues in GIS, Fort Collins, CO, GIS World Books.
6. Bolstad P. (2005) GIS Fundamentals: A First Text on Geographic Information Systems, Second Edition, White Bear Lake, MN, Eider Press
7. Kaplan E. D. and Hegarty C J (2006) Understanding GPS Principles and Applications, Second Edition, ARTECH House INC. Norwood.
8. Paul D. Groves (2013) Principles of GNSS, inertial, and multisensor integrated navigation systems, 2nd edition, Artech House, Boston/London

#### Suggested readings

1. Elangovan K. (2006) GIS: Fundamentals, Applications and Implementations, New India Publishing Agency, New Delhi.
2. Heywood I., Cornelius S. and Carver S. (2006) An Introduction to Geographical Information Systems, Prentice Hall, 3rd Edition.
3. Longley P.A., Goodchild M.F., Maguire D.J. and Rhind D.W. (2005) Geographic Information Systems and Science, Chichester, Wiley, 2nd Edition.
4. Maguire D.J., Goodchild M.F. and Rhind D.W. (1997) Geographic Information Systems: Principles and Applications, Longman Scientific and Technical, Harlow.
5. Ott T. and Swiaczny F. (2001) Time-integrative GIS, Management and Analysis of Spatio-temporal Data, Berlin/Heidelberg/New York, Springer.
6. Thurston J., Poiker T.K. and Moore J.P. (2003) Integrated Geospatial Technologies: A Guide to GPS, GIS and Data Logging, Hoboken, New Jersey, Wiley.
7. Tomlinson R.F. (2005) Thinking about GIS: Geographic Information System Planning for Managers, ESRI Press.
8. Wise S. (2002) GIS Basics, London, Taylor & Francis.
9. Worboys M. and Duckham M. (2004) GIS: A Computing Perspective, Boca Raton, CRC Press.

#### Case studies

#### Websites

#### Journals

1. Asian Journal of Geoinformatics
2. Geocarto International
3. International Journal of Geoinformatics
4. International Journal of Remote Sensing
5. ISPRS Journal of Photogrammetry and Remote Sensing
6. Journal of Indian Society of Remote Sensing
7. Remote Sensing of Environment

#### **Additional information (if any)**

##### **Magazines**

2. Coordinates
3. Geospatial today
4. GIM International
5. GIS World
6. GIS@development
7. GPS World

#### **Student responsibilities**

The students are expected to submit assignments in time and come prepared with readings when provided.

#### **Course reviewer:**

- Prof. P K Joshi, JNU
- Prof. J. K. Garg, Guru Gobind Singh Indraprastha University

|  |   |  |          |                           |
|--|---|--|----------|---------------------------|
| <b>Course title:</b> Principles of Remote Sensing  |   |  |          |                           |
| <b>Course code:</b> NRG 173  | <b>No. of credits:</b> 3  | <b>L-T-P:</b> 24-4-28                          |          | <b>Learning hours:</b> 42 |
| <b>Pre-requisite course code and title (if any):</b> None  |   |  |          |                           |
| <b>Department:</b> Department of Natural Resources   |   |  |          |                           |
| <b>Course coordinator:</b> Dr Chander Kr. Singh  |   | <b>Course instructor:</b> Dr Chander Kr. Singh |          |                           |
| <b>Contact details:</b>  |   |  |          |                           |
| <b>Course type:</b> Core   |   | <b>Course offered in:</b> Semester 1           |          |                           |
| <b>Course Description</b><br>It introduces the participant to the basic concepts and the operational skills necessary to acquire remote sensing data and extract geo-information from them. The course links the theoretical physical principles and its visualization in form of remote sensed images and thereafter develop understanding of it use for different applications of resource management. |   |  |          |                           |
| <b>Course objectives</b>   |   |  |          |                           |
| 1. To congregate the basic concepts and fundamentals of physical principles of remote sensing  |   |  |          |                           |
| 2. To create a firm basis for successful integration of remote sensing in any field of application.  |   |  |          |                           |
| <b>Course content</b>  |   |  |          |                           |
| <b>S.No</b>  | <b>Topic</b>  | <b>L</b>                                       | <b>T</b> | <b>P</b>                  |
| 1.   | Introduction to Remote Sensing, History of Remote Sensing; History of Space programs of India and World;  | 2  |          |                           |
| 2.   | EMR wavelength regions and their applications, Atmospheric windows, Interaction of EMR with matter;   | 2  |          |                           |
| 3.   | Fundamentals of Radiometry: Concept & Laws, radiance, reflectance   | 4  | 2        |                           |
| 4.   | Resolutions–spatial, spectral, radiometric, temporal  | 2  |          |                           |
| 5.   | Remote Sensing Systems (Active & Passive; Imaging & Non-imaging), Orbit and Platforms of earth Observation, sensors and scanners; Cameras and Sensor classification: Opto-Mechanical & Push-broom; Sensor for Infrared, Thermal and Microwave bands | 4  |          |                           |
| 6.   | Introduction to commonly used multi-spectral remote sensing satellite systems: IRS Series of satellites, LANDSAT, SPOT, IKONOS, QUICKBIRD, MODIS, RADARSAT, NOAA, TERRA, SENTINEL Family, RISAT, RESOURCESAT etc                                    | 4  | 2        |                           |
| 7.   | Ground Truth Collection, Visual Interpretation, Digital and analog methods of Image Interpretation  | 4  |          |                           |
| 8.   | Spectral signature and its response for Soil, Vegetation and Water  | 2  |          |                           |
|  |   |  |          |                           |
|  | <b>PRACTICALS</b>   |  |          |                           |
| 1.   | Lab 1. Introduction to ERDAS IMAGINE 2011   |  |          | 2                         |
| 2.   | Lab 2. Plotting Spectral Signature using spectroradiometer data   |  |          | 2                         |
| 3.   | Lab 3. Exploring different websites for sensor and data   |  |          | 4                         |
| 4.   | Lab 4. Satellite image; season, location, sensor  |  |          | 4                         |
| 5.   | Lab 5. Display, analysis and interpretation of black & white images, grey image, pseudo image and FCC   |  |          | 2                         |
| 6.   | Lab 6. File formats. Import / Export of files using ERDAS IMAGINE   |  |          | 2                         |
| 7.   | Lab 7. Pre-processing satellite data (stacking, subsetting, mosaicking)   |  |          | 2                         |
| 8.   | Lab 8. Map rectification of Toposheet using Keyboard or GPS data and Geo-referencing of the toposheet and imageries   |  |          | 4                         |
| 9.   | Lab 9. Collection of GPS points. Ground data collection.  |  |          | 2                         |



| <b>Course title:</b> Fundamentals of Computers and Programming   |  |                          |                                      |                           |
|--|--|--------------------------|--------------------------------------|---------------------------|
| <b>Course code:</b> NRG 101  |  | <b>No. of credits:</b> 2 | <b>L-T-P:</b> 12-4-24                | <b>Learning hours:</b> 28 |
| <b>Pre-requisite course code and title (if any):</b> None  |  |                          |                                      |                           |
| <b>Department:</b> Department of Natural Resources   |  |                          |                                      |                           |
| <b>Course coordinator:</b> Dr Neeti  |  |                          | <b>Course instructor:</b> Ms. Pooja  |                           |
| <b>Contact details:</b>  |  |                          |                                      |                           |
| <b>Course type:</b> Core   |  |                          | <b>Course offered in:</b> Semester 1 |                           |
| <b>Course Description</b><br>The module will explore the fundamentals of programming in C. The course will also include basics of data base management system through Oracle/MySQL   |  |                          |                                      |                           |
| <b>Course objectives:</b> The objectives of the course are:<br>(1) Provide fundamentals of programming<br>(2) Provide fundamentals of C programming language<br>(3) Provide fundamental knowledge of database management system which is relevant to GIS |  |                          |                                      |                           |
| <b>Course content</b>  |  |                          |                                      |                           |
| Module   | Topic  | L                        | T                                    | P                         |
| 1.   | History of Programming, Making Flow Chart  | 2                        |                                      |                           |
|  | Introduction to C, Structure of C Programme, Data type, Input and Output function, Conditional execution   | 5                        | 2                                    |                           |
| 2.   | DBMS and RDBMS<br>(MS ACCESS; ORACLE; MySQL)   | 5                        | 2                                    |                           |
|  |  |                          |                                      |                           |
|  | <b>PRACTICALS</b>  |                          |                                      |                           |
| 1  | Writing first C Programme  |                          |                                      | 2                         |
| 2  | Using different types of data in C Programme   |                          |                                      | 2                         |
| 3  | Writing a programme to use decision control statements, cases  |                          |                                      | 2                         |
| 4  | Writing a programme using loop structure, nested loop  |                          |                                      | 2                         |
| 5  | Use of Arrays  |                          |                                      | 2                         |
| 6  | Programme using pointers   |                          |                                      | 2                         |
| 7  | Design a Database and create required tables, apply the constraints like Primary Key, Foreign key, NOT NULL to the tables.   |                          |                                      | 2                         |
| 8  | Write a sql statement for implementing ALTER, UPDATE and DELETE, Write the queries to implement the joins  |                          |                                      | 2                         |
| 9  | Write the query for implementing the following functions:<br><ul style="list-style-type: none"> <li>• String Function</li> <li>• Numeric/Math Functions</li> </ul> |                          |                                      | 2                         |

|   |  |           |          |           |
|---|--|-----------|----------|-----------|
|   | <ul style="list-style-type: none"> <li>• Aggregate Functions</li> <li>• Date/Time Functions</li> </ul> |           |          |           |
| 10  | Create Functions, procedures, packages, triggers, Different types of queries using Cases               |           |          | 4         |
| 11  | Write the query to create the views, Inline view   |           |          | 2         |
|   | <b>Total</b>   | <b>12</b> | <b>4</b> | <b>24</b> |
| <b>Evaluation criteria</b>  |  |           |          |           |
| <ul style="list-style-type: none"> <li>▪ Test1: Written Test: 15%</li> <li>▪ Test2: Written Test: 15%</li> <li>▪ Lab Assignments: 10%</li> <li>▪ Practical: [Lab exam and Viva] 30%</li> <li>▪ Test3: Written Test 30%</li> </ul> <p><i>(Test 3 include entire syllabus)</i></p>  |  |           |          |           |
| <b>Learning outcomes: Students will be able to</b>  |  |           |          |           |
| <ol style="list-style-type: none"> <li>1. Describe how data are represented, manipulated, and stored in a computer [Test1, Lab Assignments]</li> <li>2. Design programme using flowchart [Test1, Lab Assignments]</li> <li>3. Able to write and execute C programme using different logical operators[Test2, Lab Assignments]</li> <li>4. Able to create database table and perform logical queries with different conditions [Lab Assignments, Test3]</li> </ol>   |  |           |          |           |
| <b>Pedagogical approach:</b> The course will be delivered through class lectures, lab exercise and tutorials.   |  |           |          |           |
| <b>Materials</b>  |  |           |          |           |
| Required text   |  |           |          |           |
| <ol style="list-style-type: none"> <li>1. Benjamin C.P. (2002) Types and Programming Languages, The MIT Press.</li> <li>2. Bruce J.M. (1999) Principles of Programming Languages: Design, Evaluation and Implementation, Oxford University Press.</li> <li>3. Daniel P.F. and Wand M. (2001) Christopher Thomas Haynes: Essentials of Programming Languages, The MIT Press.</li> </ol>  |  |           |          |           |
| Suggested readings  |  |           |          |           |
| <ol style="list-style-type: none"> <li>1. Gelernter D. and Jagannathan S. (1990) Programming Linguistics, The MIT Press.</li> <li>2. Goldschlager L. (1998) A Lister Computer Science - A Modern Introduction Prentice Hall.</li> <li>3. John C.M. (2002) Concepts in Programming Languages, Cambridge University Press.</li> <li>4. Michael L. S. (2005) Programming Language Pragmatics, Morgan Kaufmann Publishers.</li> <li>5. Sethi R. (1996) Programming Languages: Concepts and Constructs, 2nd ed., AddisonWesley.</li> <li>6. Wexelblat R.L. (1981) History of Programming Languages, Academic Press.</li> </ol> |  |           |          |           |
| Case studies  |  |           |          |           |
| Websites  |  |           |          |           |
| Journals  |  |           |          |           |
| <b>Additional information (if any)</b>  |  |           |          |           |
| <b>Magazines</b>  |  |           |          |           |
| <ol style="list-style-type: none"> <li>1. Coordinates</li> <li>2. GIM International</li> <li>3. GIS World</li> </ol>  |  |           |          |           |

- |  |
|--|
| 4. GIS@development<br>5. Goespatial today<br>6. GPS World                              |
| <b>Student responsibilities</b><br>Attendance, feedback, discipline, guest faculty etc |

**Course reviewer:**

1. Sanjay Kumar, Team Lead, AWS Software Pvt Ltd.
2. Jagdish Mutharia, Head (IT), TERI

| <b>Course title:</b> Fundamentals of Physics   |  |  |                           |          |
|--|--|--|---------------------------|----------|
| <b>Course code:</b> NRG XXX  | <b>No. of credits:</b> 2   | <b>L-T-P:</b> 20-08-0                        | <b>Learning hours:</b> 28 |          |
| <b>Pre-requisite course code and title (if any):</b> None  |  |  |                           |          |
| <b>Department:</b> Department of Natural Resources   |  |  |                           |          |
| <b>Course coordinator:</b> Dr Nithiyanandam Y  |  | <b>Course instructor:</b> Dr Nithiyanandam Y |                           |          |
| <b>Contact details:</b> nithiyanandam.y@terisas.ac.in  |  |  |                           |          |
| <b>Course type:</b> Audit  |  | <b>Course offered in:</b> Semester 1         |                           |          |
| <b>Course description:</b> The M.Sc. Geoinformatics course contains intense subjects, those require a basic knowledge in Physics for better understanding. Since, students undertake this course are from diverse backgrounds, a bridge course is required to fill this gap. Hence, a compulsory audit course of two credits is offered for students who have not done a course in Physics at 10+2 / bachelor's level. |  |  |                           |          |
| <b>Class objectives:</b><br>Develop an understanding of <ul style="list-style-type: none"> <li>• Selected fundamental concepts and principles in physics.</li> <li>• How these concepts are used in practical applications.</li> </ul>   |  |  |                           |          |
| <b>Course content</b>  |  |  |                           |          |
| S no   | Topic  | L  | T                         | P        |
| 1  | Measurement: The International system of Units, Changing units, length, time and mass; Motion along a straight line, two and three dimensions: Motion, position and displacement, average velocity and speed, instantaneous velocity and speed, acceleration, constant and free fall accelerations, momentum, projectile motion, circular motion, and relative motion.                           | 2  | 1                         | 0        |
| 2  | Force and motion: Newtonian mechanics, Newton's first law, force, mass, Newton's second law, Newton's third law, friction, drag force.   | 2  | 0                         | 0        |
| 3  | Energy: what is energy? Kinetic energy, Work and kinetic energy, work done by the gravitational and general variable forces, and power; Potential energy, work and potential energy, determining potential energy values, conservation of energy.  | 2  | 1                         | 0        |
| 4  | Gravitation: Newton's law of gravitation, gravitation and the principle of superposition, gravitation near earth's surface, gravitation inside earth, gravitation potential energy, planets and satellites: Kepler's law, Satellites: orbits and energy, Einstein and gravitation.   | 2  | 1                         | 0        |
| 5  | Oscillation: simple harmonic oscillation, energy in simple harmonic motion, pendulums and circular motion, forced oscillation and resonance.<br>Waves: types of wave, wavelength and frequency, the speed of a travelling wave, the wave equation, interference of waves, sound waves, travelling sound waves, intensity and sound level, the Doppler effect, supersonic speeds and shock waves. | 2  | 1                         | 0        |
| 6  | Thermodynamics: Temperature, the zeroth law of thermodynamics, measuring temperature, thermal expansion, temperature and heat, first and second laws of thermodynamics, heat transfer mechanisms.  | 2  | 1                         | 0        |
| 7  | Electromagnetic waves: Maxwell's rainbow, the travelling electromagnetic wave, radiation pressure, reflection and refraction, total internal reflection, polarization by reflection;<br>Optics: Types of images, mirrors, interference, diffraction and polarization, Geometrical optics, dispersion of lights and optical instruments; Interference, diffraction and relativity.                | 4  | 2                         | 0        |
| 8  | Energy from nucleus: Nuclear fission, nuclear reactor, thermonuclear fusion, cosmology, the cosmic background radiation, dark matter, the big bang.  | 2  | 0                         | 0        |
| 9  | Applications of physics fundamentals in geospatial technologies.   | 2  | 1                         | 0        |
| <b>Total</b>   |  | <b>20</b>                                    | <b>8</b>                  | <b>0</b> |
| <b>Evaluation criteria</b><br>Test 1: Written Test: 15%  |  |  |                           |          |

|  |
|--|
| Test 2: Written Test: 15%<br>Test 3: Written Test: 40%<br>Tutorials/assignments/Quizzes: 30%   |
| <b>Learning outcomes:</b><br>Upon completion of this course, a student will be able to: <ul style="list-style-type: none"> <li>• Understand basic concepts and principles in different branch of physics like energy, thermodynamics, waves, and optics. [Test1, Test2, Tutorials/assignments/Quizzes]</li> <li>• Realise the physics behind remote sensing thought in other courses. [Test3]</li> </ul>   |
| <b>Pedagogical approach:</b> : The course will be delivered through class lectures and tutorials.  |
| <b>Materials:</b><br><b>Books:</b> <ol style="list-style-type: none"> <li>1. Christman, J. R. <i>et al.</i> (1997) <i>Student's companion, Fundamentals of physics</i>. Wiley.</li> <li>2. Elachi, C. and van Zyl, J. J. (2006) <i>Introduction To The Physics and Techniques of Remote Sensing</i>. Wiley (Wiley Series in Remote Sensing and Image Processing).</li> <li>3. Giambattista (2010). <i>Fundamentals Of Physics (sie)</i> McGraw-Hill Education (India) Pvt Limited.</li> <li>4. Halliday, D., Resnick, R. and Walker, J. (2010) <i>Fundamentals of Physics</i>. John Wiley &amp; Sons.</li> <li>5. Rees, G. and Rees, W. G. (2012) <i>Physical Principles of Remote Sensing</i>. Cambridge University Press.</li> </ol> |
| <b>Additional information (if any)</b>   |
| <b>Student responsibilities:</b><br>Attendance, Feedback, discipline, and timely submission of assignments.  |

**Course Reviewers:**

- Dr A.R.Prabhakaran, Associate professor of Physics, Pachaiyappa's College, University of Madras.
- Mr. Samudraiah, Former Deputy Director, Space Application Center, ISRO.



|  |   |  |  |          |
|--|---|--|--|----------|
| <b>Course title: Health Finance</b>  |   |  |  |          |
| <b>Course code:</b>  | <b>No. of credits: 3</b>  | <b>L-T-P distribution: 34-8-0</b>                  | <b>Learning hours: 42</b>                    |          |
| <b>Pre-requisite course code and title (if any):</b>   |   |  |  |          |
| <b>Department:</b> Department of Business and Sustainability   |   |  |  |          |
| <b>Course coordinator (s):</b> Dr. Montu Bose  |   |  | <b>Course instructor (s):</b> Dr. Montu Bose |          |
| <b>Contact details:</b>  |   |  |  |          |
| <b>Course type</b>   | Elective  | <b>Course offered in:</b> 3 <sup>rd</sup> Semester |  |          |
| <b>Course description</b>  |   |  |  |          |
| <p>One of the goals (SDG 3) in the ambitious development agenda of the Sustainable Development Goals (SDGs), adopted by the United Nations on 25<sup>th</sup> September 2015, requires substantial investments for providing financial risk protection and achieve Universal Health Coverage (UHC). To protect the households from financial risk due to health expenditure, different countries (&amp; states) have adopted a variety of health financing strategies. The out-of-pocket (OOP) expenditure or direct payments, one of the major contributor to healthcare payment in most of the developing countries, made by individuals to healthcare providers at the time of service use, is considered as the most regressive form of healthcare payment. It owes to low public healthcare spending coupled with poor regulatory policy and monitoring over private healthcare providers in these countries. This results in absorbing a significant portion of a household budget and pushing them to sacrifice many other basic needs of their well-being, such as food, apart from making them economically poorer.</p> <p>This course has been developed in this background. It is aimed at offering an exhaustive understanding to the students on health financing mechanisms across spatio-temporal locations. In particular, it will help a student to understand the mechanisms from the perspective of multiple stakeholders, such as the State, consumer/patient, hospital/healthcare provider, medical insurance companies, interest groups (national/international), etc.</p> |   |  |  |          |
| <b>Course objectives</b>   |   |  |  |          |
| The course aims to –   |   |  |  |          |
| <ul style="list-style-type: none"> <li>• Expose the students to the organization and financing of the health care system to understand the importance of health financing mechanisms;</li> <li>• To provide the students an exposure to different health financing mechanisms across time and space to gain an understanding to their applicability, efficiency and appropriateness in different socio-economic-political conditions</li> <li>• Make them familiar with the advantages and limitations of different health financing mechanisms and strategies adopted across countries/states at various stages of its life cycle-from conceptualisation to implementation;</li> <li>• Enable them to understand the requirements of health financing mechanisms which can be financially sustainable/viable.</li> </ul>  |   |  |  |          |
| <b>Course content</b>  |   |  |  |          |
| <b>Module</b>  | <b>Topic</b>  | <b>L</b>   | <b>T</b>                                     | <b>P</b> |
| 1.   | <b>Introduction: Health related Development Goals, Health Sector Reform &amp; Health Financing</b><br>Problems of healthcare system<br>Forces of driving health reform<br>Health-reform cycle<br>Goals of Universal Health Coverage (UHC) & health financing<br>Beyond health financing: the wider health system & economy.                                       | 5  | 0  |          |
| 2.   | <b>Sources of Revenue for Health Financing</b><br>Different sources of raising revenue – compulsory or voluntary, prepayment or out-of-pocket, domestic or foreign;<br>revenue raising and policy objectives;<br>fiscal space & health financing;<br>role of public spending on healthcare;<br>case studies from Thailand, Bangladesh & Sri Lankan health system. | 6  | 1  |          |

|    |  |    |    |  |
|----|--|----|----|--|
| 3. | <b>Pooling Mechanism in Health Financing</b><br>Policy objectives and the role of pooling,<br>desirable characteristics of resource-pooling,<br>fragmentation in pooling and the role of policy makers,<br>insurance mechanism: public & private sector;<br>case studies from Thailand, Bangladesh & Sri Lankan health system.           | 7  | 2  |  |
| 4. | <b>Purchasing Healthcare Services</b><br>Types of healthcare purchasing;<br>Strategic purchasing;<br>challenges of the purchasers, institutional arrangements & purchasing<br>instruments;<br>paying different healthcare services,<br>provider payment mechanism;<br>case studies from Thailand, Bangladesh & Sri Lankan health system. | 5  | 1  |  |
| 5. | <b>Designing Benefit Package</b><br>Publicly funded benefit package for health,<br>role of rationing,<br>coverage choice,<br>benefit package & UHC promotion;<br>cost effective interventions;<br>case studies from Thailand, Bangladesh & Sri Lankan health system.   | 6  | 2  |  |
| 6. | <b>Policies for UHC: Indian Experience</b><br>Comparison of Indian Health system with the developed countries,<br>health financing in Indian States: Cases from Kerala, Tamil Nadu, Punjab,<br>Maharashtra, Odisha, Madhya Pradesh & West Bengal;<br>Evaluation of Health Financing Strategies of the states.                            | 5  | 2  |  |
|    |  | 34 | 8  |  |
|    | <b>Total</b>   |    | 42 |  |

### Evaluation criteria

The break-up of the evaluation procedure is as follows –

**Test 1:** Written Examination – (Module 1) 20%

**Test 2:** Case-study preparation – (after completion of Module 2-4) 20%

i. Structure: (1) identification of an important problem related to revenue raising/pooling/purchasing; (2) explain why it is important for the country/state/province from the health financing perspective; (3) how has this problem been addressed in the literature (both empirical and theoretical); (4) where is the scope of improvement - in policy, method etc.; (5) analysis and/or use of data & methodology (if needed); (6) clear explanation of the result with conclusion.

ii. Indicators for assessment: (a) Identification of the problem; (b) Identification of specific research question(s); (c) Structure and referencing; (d) Content, language, clarity (Academic Merit); (e) punctuality & timeline adherence.

Note: (d) shall carry a weight of 50%; (a) & (b) shall carry 15% each; the rest will carry 10% each 20%

**Test 3:** Writing of a macro level data analysis report – (Module 6)20%

i. Structure: (1) identification of an important problem related to health financing; (2) explain why it is important for the country/state/province from the health financing perspective; (3) how has this problem been addressed in the literature (both empirical and theoretical); (4) where is the scope of improvement - in policy, method etc.; (5) specify the objective of the work; (6) clearly mention the data source and methodology (7) explain & discuss the results obtained; (8) policy directions/ recommendations & scope of further research.

ii. Indicators for assessment: (a) Identification of the problem; (b) Identification of specific research question(s); (c) Structure and referencing; (d) Content, language, clarity (Academic Merit); (e) punctuality & timeline adherence.

Note: (d) shall carry a weight of 50%; (a) & (b) shall carry 15% each; the rest will carry 10% each

**Test 4:** Written Examination (Module 2-5) - 40%

**Learning outcomes:** After successful completion of the course, students will be able to –

- Develop an exhaustive understanding of the health financing systems (Test 1 and 4)

- Ability to identify and analyse the sources of health financing in different economic system (Test 2)
- Ability to understand the different methods and extent of pooling in health financing and its impact on equity (Test 2)
- Develop an understanding in different purchasing mechanism and the best practices in the various contexts (Test 3 and 4)
- Ability to evaluate the health financing system and prescribe policies for better health outcome and to achieve SDGs (Test 3 and 4)

### **Pedagogical approach**

The course will be delivered through lectures and discussion of case studies, research papers and articles.

### **Materials**

#### **Books**

- *Gottret, Pablo & Schieber (2006). Health Financing Revisited: A Practitioner's Guide.* Washington, DC: World Bank.
- Josep, Ray & Elke (Eds.) (2005). *Purchasing to improve health systems performance.* Open University Press European Observatory on Health Systems and Policies series.
- Zweifel & Breyer. (1997). *Health Economics.* Oxford University Press.

#### **Reports & other references:**

- Antos JR. (2007). *Health Care Financing in Thailand: Modeling & Sustainability.* Mission Report to the World Bank. Bangkok.
- Bose M., Indranil M., Vaidyanathan G. et.al. (2017). *Tamil Nadu State Health Accounts 2013-14.* PHFI, New Delhi.
- Mishra A. & Seshdari S.R. (2015): *Unpacking the Discourse on Universal Health Coverage in India,* *Social Medicine,* 9(2), 86-92.
- Muraleedharan VR, Umakant D. & Lucy G. (2011). *Tamil Nadu 1980s – 2005: A Success Story in India,* in ed. Dian B, Martin M & Anne M., *Good Health at Low Cost 25 Years on What makes a successful health system?*
- National Health System Resource Centre (2016). *National Health Accounts Estimates for India (2013-14).* Ministry of Health & Family Welfare, GoI.
- Planning Commission of India (2011): *High Level Expert Group Report on Universal Health Coverage for India.*  
([http://planningcommission.nic.in/reports/genrep/rep\\_uhc0812.pdf](http://planningcommission.nic.in/reports/genrep/rep_uhc0812.pdf)).
- Prinja S., Manmeet K. & Rajesh K. (2012): *Universal Health Insurance in India: Ensuring Equity, Efficiency, and Quality,* *Indian Journal of Community Medicine,* 37(3), 142-49.
- Public Health Foundation of India (PHFI) 2016. *State Health Accounts Madhya Pradesh.*
- Public Health Foundation of India (PHFI) 2016. *State Health Accounts Odisha.*
- Public Health Foundation of India (PHFI) 2016. *State Health Accounts Maharashtra.*
- Public Health Foundation of India (PHFI) 2016. *State Health Accounts Kerala.*
- Public Health Foundation of India (PHFI) 2016. *State Health Accounts Punjab.*
- Qadeer I. (2013): *Universal health care in India: Panacea for whom?* *Indian Journal of Public Health,* 57(4), 225-30.
- Roberts MJ., William H., Peter B. & Michael RR. (2008). *Getting Health Reform Right.* OUP. New York.
- The World Bank (2009). *Working in Health: Financing & Managing the Public Sector Health Workforce.*

#### **Web References:**

Global Network for Health Equity, available at: <http://gnhe.org/blog/category/south-east-asia/>

WHO, Health financing for universal coverage, available at: [http://www.who.int/health\\_financing/training/e-learning-course-on-health-financing-policy-for-uhc/en/](http://www.who.int/health_financing/training/e-learning-course-on-health-financing-policy-for-uhc/en/)

WHO, 'Health financing for universal coverage, available online at:

[http://www.who.int/health\\_financing/policy-framework/en/](http://www.who.int/health_financing/policy-framework/en/)

WHO, Health Financing, available at: [http://www.who.int/health\\_financing/en/](http://www.who.int/health_financing/en/)

WHO, India, available at: <http://www.who.int/countries/ind/en/>

WHO, Health Financing, available at: [http://www.who.int/health\\_financing/topics/sustainable-financing-](http://www.who.int/health_financing/topics/sustainable-financing-)

[for-uhc/en/](#)

**Additional information (if any)**

**Student responsibilities**

Attendance, timeline adherence for assignments, come prepared with readings when provided.

**Course reviewers:**

1. Dr. Umakant Dash, IIT-Madras
2. Dr. Arijita Dutta, University of Calcutta

|  |  |  |  |          |
|--|--|--|--|----------|
| <b>Course title:</b> Fundamentals of Management  |  |  |  |          |
| <b>Course code:</b>  | <b>No. of credits:</b> 2   | <b>L-T-P distribution:</b> 28-0-0                  | <b>Learning hours:</b> 28                    |          |
| <b>Pre-requisite course code and title (if any):</b>   |  |  |  |          |
| <b>Department:</b> Department of Business and Sustainability   |  |  |  |          |
| <b>Course coordinator (s):</b> Ritika Mahajan  |  |  | <b>Course instructor (s):</b> Ritika Mahajan |          |
| <b>Contact details:</b>  |  |  |  |          |
| <b>Course type</b>   | <b>Core</b>  | <b>Course offered in:</b> 1 <sup>st</sup> Semester |  |          |
| <b>Course description</b><br>The purpose of management education is to provide all round knowledge, theoretical and practical, that adds value to any managerial decision a person takes in the interest of whoever she or he is serving. It is all pervasive and not just limited to the corporate or business sector. The job of a manager is to get the best out of people and enable them to get the best out of resources. However, this is easier said than done; it requires knowledge and experience. This course will provide students an understanding of basic theories and concepts of management while exploring the role of a manager in various forms of organizations. Based on readings followed by class debates and discussions, the purpose is to generate food for thought for understanding and evaluating the evolution of management thought as well as shaping of contemporary management practices affected by factors like organizational structure, culture, communication patterns as well as the macro-business environment. |  |  |  |          |
| <b>Course objectives</b><br>The objectives are: <ul style="list-style-type: none"> <li>• To impart knowledge about different forms of organizations, and changing roles and responsibilities of a manager</li> <li>• To explain and discuss historical evolution of management thought and contemporary management approaches</li> <li>• To explore managerial challenges in different organizations and discuss choices and appropriate strategies</li> </ul>   |  |  |  |          |
| <b>Course content</b>  |  |  |  |          |
| <b>Module</b>  | <b>Topic</b>   | <b>L</b>   | <b>T</b>                                     | <b>P</b> |
| 1.   | Understanding an Organization and Forms of Organizations   | 2  | -  | -        |
| 2.   | Introduction to Business and Management with an emphasis on Tripple-Bottom Line Approach   | 2  | -  | -        |
| 3.   | Philosophical Foundation of Management; Evolution of Management Thought – Historical Trajectory; Traditional and Contemporary Perspectives   | 4  | -  | -        |
| 4.   | Functions, Roles, and Skills of Managers; Real-life Challenges including authority types, flows and responsibility; Comparison with a World Without Management   | 4  | -  | -        |
| 5.   | Management of different forms of organizations including family owned businesses, platforms, networks including blockchains; managing inter-firm linkages  | 4  | -  | -        |
| 6.   | Decision Making- Understanding and Solving Complex Problems; Bounded Rationality, Escalation of Commitment, Decision-Making Errors; the Implementation Challenge with reference to Sustainable Development | 4  | -  | -        |
| 7.   | Managing the Business Environment with reference to economic, social, cultural, political, and global issues   | 3  | -  | -        |
| 8.   | Organizational Structure and Culture: Meaning, Impact and Inter-relationship   | 2  | -  | -        |
| 9.   | AI/Analytics and the changing role of Managers   | 3  | -  | -        |
|  | <b>Total</b>   | <b>28</b>  | <b>-</b>                                     | <b>-</b> |
| <b>Evaluation criteria</b>   |  |  |  |          |
| ■  |  | Test 1: Presentation                               | 30%  |          |

- Test 2: Assignment 30%
- Test 3 (End-Term Exam) 40%

#### **Test 1 (at the end of module 4)**

Structure: The students will be required to identify an organization in consultation with the course instructor and make a presentation covering the following aspects (a) about the organization- name, size, leadership, local/global presence, type of business operations etc. (b) critical review of the structure based on internal factors like centralization or decentralization of power, delegation of authority, communication channels, span of management etc. as well as external issues like competition, political environment, socio cultural constraints etc.

Parameters: The parameters for evaluation would include identification of the organization, method, understanding of theoretical base, rigor in review of data, logic of arguments and relevance of conclusions, presentation structure, formatting and timeliness. Equal weightage will be given to all the six components.

#### **Test 2 (at the end of module 6)**

Structure: The students will be required to analyze two case-studies distributed by the course instructor and submit a written assignment (6-8 pages, Times New Roman, 12-point font size, 1.5 line spacing). The analysis would include (a) identification of problem and (b) appropriate strategies to deal with the problem.

Parameters: The parameters for evaluation will be analytical ability, originality, logic of argument, timeliness, structure & formatting. Weightage for these five components would be equal.

#### **Test 3 End-Term Exam (at the end of all modules)**

This will be an open book exam based on all the modules covered in the class.

#### **Learning outcomes**

By the end of the course, the students should be able to:

- Demonstrate an understanding of different organizations and associated managerial challenges (Test 1 and 2)
- Apply different approaches in the context of real-life challenges (Test 1 and 2)
- Ability to assimilate and critically evaluate basic theories and concepts of management (Test 1, 2 and 3)

#### **Pedagogical approach**

The course will be delivered through lectures, discussions based on suggested readings, games, and presentations. The students will be required to prepare suggested readings in advance to discuss the module-wise topics in the class.

#### **Materials**

Reading material to be suggested by faculty.

#### **Books:**

Koontz, H and Weihrich, H, Essentials of Management, Tata McGraw Hill  
 Robbins, SP and Coulter, M, Management, Prentice Hall  
 Koontz, H, Principles of Management, Tata McGraw-Hill  
 Drucker, PF, Management, Harper Collins

#### **Suggested Readings:**

##### Books

Kahneman, D (2013). Thinking Fast and Slow, Farrar, Straus and Giroux.  
 Mintzberg, H (2003). Managers not MBAs, Berrett-Koehler.  
 Pink, DH (2011). Drive, Riverhead Books.  
 Stone, D, Patton, B, and Heen, S (2011). Difficult Conversations, Penguin Books.  
 Wallace, A and Catmull, E (2014). Creativity Inc, Transworld Publishers.

##### Papers/Articles

Backer, PR (1998). Scientific Management. Available

at: [www.engr.sjsu.edu/pabacker/scientific\\_mgt.htm](http://www.engr.sjsu.edu/pabacker/scientific_mgt.htm).

Bell, K (2016). The Management Ideas that Mattered Most in 2016. Available at:

<https://hbr.org/2016/12/the-management-ideas-that-mattered-most-in-2016>

Buckingham, M (2005). What Great Managers Do? Available at <https://hbr.org/2005/03/what-great-managers-do>.

Drucker, P (2005). Managing Oneself. Available at <https://hbr.org/2005/01/managing-oneself>

Gino, F (2016). Let Your Workers Rebel. Available at:

[https://www.hbs.edu/faculty/Publication%20Files/Let%20your%20workers%20rebel\\_b87d0da9-de68-45be-a026-22dee862e6e4.pdf](https://www.hbs.edu/faculty/Publication%20Files/Let%20your%20workers%20rebel_b87d0da9-de68-45be-a026-22dee862e6e4.pdf)

Hoopes, J (2003). False Prophets: The Gurus Who Created Modern Management and Why Their Ideas are Bad for Business Today. Available at <https://www.tandfonline.com/doi/abs/10.1177/1744935906060627>

Milkman, KL, Chugh, D and Bazerman, MH (2008). How can decision making be improved? Available at:

<http://www.hbs.edu/faculty/Publication%20Files/08-102.pdf>

Mintzberg, H (1990). Manager's Job: Facts and Folklore. Available at:

<http://rafael.glendale.edu/ppal/Busad%20101/mintzbergmar1990.pdf>

Oncken, W and Wass, D (1999). Management Time: Who's Got the Monkey? Available at:

<https://hbr.org/1999/11/management-time-whos-got-the-monkey>

Scott, WG and Hart, DK (1971). The moral nature of man in organizations: a comparative analysis, Academy of Management Journal. Available at: <https://journals.aom.org/doi/abs/10.5465/255310>

Simha, A and Lemak, DJ (2010). The Value of Original Source Readings in Management Education: The Case Of Frederick Winslow Taylor. Available at

<https://www.emeraldinsight.com/doi/abs/10.1108/17511341011030129>

Zengar, J and Folkman, J (2018). Why the Most Productive People Don't Always Make the Best

Managers? Available at: <https://hbr.org/2018/04/why-the-most-productive-people-dont-always-make-the-best-managers>

**Additional information (if any)**

**Student responsibilities**

**Course reviewers:**

1. Dr Vinay Sharma, IIT Roorkee
2. Dr Kumkum Bharti, IIM Kashipur

|   |  |                                      |  |          |
|---|--|--------------------------------------|--|----------|
| <b>Course title:</b> Organizational Behaviour and Leadership  |  |                                      |  |          |
| <b>Course code:</b>   | <b>No. of credits:</b> 2   | <b>L-T-P distribution:</b> 28-0-0    | <b>Learning hours:</b> 28                    |          |
| <b>Pre-requisite course code and title (if any):</b>  |  |                                      |  |          |
| <b>Department:</b> Department of Business and Sustainability  |  |                                      |  |          |
| <b>Course coordinator (s):</b> Ritika Mahajan   |  |                                      | <b>Course instructor (s):</b> Ritika Mahajan |          |
| <b>Contact details:</b>   |  |                                      |  |          |
| <b>Course type</b>  | <b>Core</b>  | <b>Course offered in:</b> Semester 2 |  |          |
| <b>Course description</b>   |  |                                      |  |          |
| <p>In today's dynamic environment, organizational behaviour and leadership are critical differentiating factors for organizational success and excellence. There are continuous changes in social, political, cultural, global as well as economic environment, and an understanding of organizational behaviour and leadership is essential for future managers to manage such changes through strategic choices anchored in the vision of the organization and its people. This course will cover organizational behaviour theory and research in the context of current realities. The purpose is to impart state of art knowledge in the field of OB and imbibe professional and broad humanistic values that leaders must possess for steering the teams and organisations to achieve excellence while safeguarding the interest of all stakeholders, including society and environment.</p> |  |                                      |  |          |
| <b>Course objectives</b>  |  |                                      |  |          |
| The objectives are:   |  |                                      |  |          |
| <ul style="list-style-type: none"> <li>• To impart knowledge about classical and contemporary OB theories and concepts;</li> <li>• To sensitize students about managing diversity among people and deal with behavioral issues in organizations;</li> <li>• To prepare students for leadership challenges in different forms of organizations.</li> </ul>   |  |                                      |  |          |
| <b>Course content</b>   |  |                                      |  |          |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>                             | <b>T</b>                                     | <b>P</b> |
| 1.  | Introduction to Organizational Behaviour- Classical and Neoclassical Approaches; Organizational Development  | 2                                    | 0  | 0        |
| 2.  | Individual Behaviour- Knowing and Managing Yourself; Unleashing Creativity (Self and Others)   | 2                                    | 0  | 0        |
| 3.  | Exploring Roles and Identities through an understanding of Values, Personalities, Emotions (Emotional Intelligence), Attitudes, and Perceptions  | 4                                    | 0  | 0        |
| 4.  | Gender issues in Workplace (including Sexual Harassment)   | 2                                    | 0  | 0        |
| 5.  | Motivation; early and contemporary theories; self-motivation; sustainable motivation   | 2                                    | 0  | 0        |
| 6.  | Teams v/s groups; why teams, the journey of designing and sustaining effective teams, working in virtual teams   | 2                                    | 0  | 0        |
| 7.  | Communication Skills for Team Effectiveness; Difficult Conversations and Persuasive Communication; Intercultural Communication; Communication in Digital Era   | 2                                    | 0  | 0        |
| 8.  | Change Management: Overview; Impact of Change; Role of Organization Structure and Culture; Managing across cultures  | 2                                    |  |          |
| 9.  | Leadership- Managers versus Leaders; Perspectives of leadership: Trait, Behavioral, Contingency; Types/Styles: Transactional, Transformational, Charismatic Leadership, and Democratic, Autocratic and Free Rein; Leadership and Innovation; Leadership for sustainable development; Corporate Governance and Leadership; Followership | 8                                    | 0  | 0        |
| 10.   | Role of trust in organizational context; power and politics  | 2                                    | 0  | 0        |
|   | <b>Total</b>   | <b>28</b>                            | <b>0</b>                                     | <b>0</b> |
| <b>Evaluation criteria</b>  |  |                                      |  |          |
| ▪   | Test 1: Assignment   | 30%                                  |  |          |
| ▪   | Test 2: Presentation   | 30%                                  |  |          |
| ▪   | Test 3: End-Term Exam  | 40%                                  |  |          |



**Test 1 (at the end of module 4)**

Structure: The students will be required to identify an organization in consultation with the course instructor and submit a report based on analysis of primary and/or secondary data covering critical review of any one dimension like job satisfaction, values, leadership, organizational citizenship behaviour, emotional intelligence, types of communication etc. Each report shall focus on one dimension to be decided in consultation with the course instructor.

Parameters: Type of data; originality; timeliness, structure and formatting; logic of arguments and flow of thoughts; understanding of theoretical base will be the parameters for evaluation. All five components carry equal weightage.

**Test 2 (at the end of module 8)**

Structure: The students will be required to select one book- an autobiography/biography/life-history of a leader, in consultation with the course instructor, and make a presentation covering (a) summary of the book and its salient features (b) reflection on the leadership qualities of the person (c) debate on whether leaders are born or made and (d) a critical evaluation of their own leadership ability.

Parameters: The parameters for evaluation include structure and layout, originality, analytical ability, and presentation skills including audio-visual aids, body language, voice modulation etc. Each component carries weightage of 25 percent.

**Test 3 (End-Term Exam; at the end of all modules)**

This will be an open book exam based on all the modules covered in the class.

**Learning outcomes**

By the end of the course, the students should be able to:

- Demonstrate an understanding of organizations as complex and pluralistic places where both conflict and cooperation are normal occurrences (Test 1, 2 and 3)
- Ability to reflect on their personal leadership skills and ability to exhibit leadership qualities in organizations (Test 2)
- Ability to assimilate, and apply knowledge of basic theories and concepts to solve organizational behaviour problems (Test 1, 2 and 3)

**Pedagogical approach**

The course will be delivered through lectures, discussions based on suggested readings, games, and presentations. The students will be required to prepare suggested readings in advance to discuss module-wise topics in the class.

**Materials**

Reading material to be distributed by faculty.

**Textbook**

Robbins, SP, Organizational Behaviour, Pearson Education

**Suggested Books**

Bade, J, Bade, S, and Hilton, S, More Human (2015), Public Affairs

Collins, J, Good to Great (2001), Willian Collins

Horowitz, B, The Hard Thing about Hard Things (2014), Harper Business

Sinek, S, Leaders Eat Last (2014), Penguin Books

Slywotzky, A, and Weber, K (2011), Demand, HighBridge

Wallace, A and Catmull, E (2014), Creativity Inc, Transworld Publishers

**Suggested Articles/Papers**

Amabile, T (1997). Motivating Creativity in Organizations. Available at

<http://bear.warrington.ufl.edu/weitz/mar7786/articles/amabile%20ccal%20mgt%20review.pdf>

Available at <https://www.sciencedirect.com/science/article/pii/S0191308517300072>

Giles, S (2016). The Most Important Leadership Competencies According to Leaders Around the World.

Available at <https://hbr.org/2016/03/the-most-important-leadership-competencies-according-to-leaders->

[around-the-world](#)

Grant, A, Gino, F and Hoffman, D. Reversing the Extraverted Leadership Advantage: The Role Of Employee Proactivity. Available at

[https://static1.squarespace.com/static/55dcde36e4b0df55a96ab220/t/GrantGinoHofmann\\_Reversing.pdf](https://static1.squarespace.com/static/55dcde36e4b0df55a96ab220/t/GrantGinoHofmann_Reversing.pdf)

Harvey, EO (2018). 5 Behaviours of Leaders Who Embrace Change. Available at <https://hbr.org/2018/05/5-behaviors-of-leaders-who-embrace-change>

Houser, O (2017). Innovation with field experiments: Studying organizational behaviors in actual organizations. Available at <https://www.sciencedirect.com/science/article/pii/S0191308517300059>

Jarret, M (2017). The 4 Types of Organizational Politics. Available at <https://hbr.org/2017/04/the-4-types-of-organizational-politics>

Lee, MY and Edmondson, AC (2017). Self-managing organizations: Exploring the limits of less-hierarchical organizing. Available at <https://www.sciencedirect.com/science/article/pii/S0191308517300059>

Lunenburg, FC (2011). Leadership versus Management- A Key Distinction – At Least in Theory. Available at

[https://cs.anu.edu.au/courses/comp3120/local\\_docs/readings/Lunenburg\\_LeadershipVersusManagement.pdf](https://cs.anu.edu.au/courses/comp3120/local_docs/readings/Lunenburg_LeadershipVersusManagement.pdf)

Ridgeway, E (2010). Why Introverts Can Be Good Leaders? Available at:

<http://edition.cnn.com/2010/BUSINESS/11/29/introverts.leadership/index.html>

Traphagan, J (2017). We're Thinking About Organizational Culture All Wrong. Available at

<https://hbr.org/2017/01/were-thinking-about-organizational-culture-all-wrong>

**Additional information (if any)**

**Student responsibilities**

**Course reviewers:**

Dr Vinay Sharma, IIT Roorkee

Dr Kumkum Bharti, IIM Kashipur

|   |  |                                      |   |          |
|---|--|--------------------------------------|---|----------|
| <b>Course title:</b> Sustainability Reporting   |  |                                      |   |          |
| <b>Course code:</b><br>PPM 163  | <b>No. of credits:</b> 2   | <b>L-T-P distribution:</b> 18-10-0   | <b>Learning hours:</b><br>28                      |          |
| <b>Pre-requisite course code and title (if any):</b>  |  |                                      |   |          |
| <b>Department:</b> Department of Business Sustainability  |  |                                      |   |          |
| <b>Course coordinator (s):</b> Dr. Sapna A. Narula  |  |                                      | <b>Course instructor (s):</b> Dr. Sapna A. Narula |          |
| <b>Contact details:</b> Sapna.narula@terisas.ac.in  |  |                                      |   |          |
| <b>Course type</b>  | Core   | <b>Course offered in:</b> Semester 1 |   |          |
| <b>Course description</b><br>Sustainability reporting is the practice adopted by organizations for measuring, communicating, and being accountable to internal and external stakeholders for organizational performance towards the goal of sustainable development. ‘Sustainability reporting’ is a broad term considered synonymous with others used to describe reporting on economic, environmental, and social impacts (e.g., triple bottom line, corporate responsibility reporting, etc.). As the stakeholders like government agencies, employees, investors, financial institutions, community, NGOs, consumers, etc. have become more demanding and are asking the companies to disclose information on its social, environmental and economic impacts, it has become necessary for the companies to communicate and engage all these stakeholders in the decision-process and hence sustainability reporting has emerged to be an important tool for stakeholder engagement and communication. |  |                                      |   |          |
| <b>Course objectives</b>  |  |                                      |   |          |
| <ul style="list-style-type: none"> <li>• To familiarize students with the rationale and process of sustainability reporting</li> <li>• To equip students with the sustainability practices in Indian /Multinational firms</li> <li>• To impart knowledge about sustainability guidelines, frameworks and standards and enable them to manage sustainability reporting process of a firm</li> </ul>  |  |                                      |   |          |
| <b>Course content</b>   |  |                                      |   |          |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>                             | <b>T</b>  | <b>P</b> |
| 1.  | <b>Introduction to Sustainability Reporting</b><br>The concept of Environment, Business and Society, Sustainability and the Role of Corporation, The Triple Bottom Line Approach to Business, Role of financial and non-financial disclosures and reporting What is sustainability Reporting, Need and benefits for Sustainability Reporting, Sustainability Report as a tool for sustainability risk assessment and stakeholder communication on sustainability performance.<br><br>Case: Green IT at Wipro                                 | 2                                    | 0   | 0        |
| 2.  | <b>Monitoring and Measuring Sustainability Performance</b><br>Establishing a sustainability management framework based of policy, system and procedures. Measuring, monitoring and improving sustainability performance. Establishing sustainability indicators and developing goals for organization<br><br>Case: Sustainability at Millipore   | 4                                    | 0   | 0        |
| 3.  | <b>Sustainability related management standards and Indices</b><br>GRI Standards, Framework: disclosure requirements, Performance Indicators [Economic, Environmental, Labour Practices, Human Rights, Society, Product Responsibility] UN Global compact; OECD guidelines for Multinational Enterprises; The CERES Principles; Social Accountability 8000; Ethical Trading Initiative’s Base Code; ICC OECD principles of Corporate Governance, ISO9001 Quality Management Standard; ISO 14001 Environmental Management System Standard; ISO | 6                                    | 4   | 0        |



which will help them develop their analytical as well as conceptual skills. The students would be expected to solve case studies on sustainability assessments and sustainability reporting. To give them practical exposure, they would be asked to prepare a sustainability report for a selected company Both case study presentations as well as projects are group assignments. Students are expected to work in the group of 4-5 for working out case solutions. The alternative solutions from all the groups will then be discussed in class. Since there is no specified text book on sustainability, the instructor will largely depend on various articles, websites in the related area and these shall be provided to the students from time to time and will form part of class discussions. The course will also have an experience sharing module where various sustainability practitioners would be invited from industry, NGOs, PSUs to share their hands on experience on relevant topics pertaining to sustainability reporting

### **Materials**

Rogers, Jalal & Boyd: An Introduction to Sustainable Development, PHI Learning,2007  
 Singh. Triple Bottom Line Reporting and Corporate Sustainability, PHI learning,2006  
 J.G. Stead & Edward Stead: Sustainable Strategic Management, M. E. Sharpe & Co., 2004.  
 J.G. Stead & Edward Stead: Management for a Small Planet, M.E. Sharpe& Co.,2009

### **WebLinks**

<https://www.globalreporting.org/reporting/reporting-frameworkoverview/Pages/default.aspx> <http://www.sustreport.org/business/report/intro.html>  
<https://www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-TechnicalProtocol.pdf>  
<http://www.enviroreporting.com/>  
<http://www.tatamotors.com/sustainability/pdf/GRI-report-07-08.pdf>  
[http://www.kpcindia.com/Pdf/Business/Sustainability%20Reporting%20\(Under%20GRI\).pdf](http://www.kpcindia.com/Pdf/Business/Sustainability%20Reporting%20(Under%20GRI).pdf)  
[http://www.sustainabledevelopment.in/services/corporate\\_sustainability\\_management/actities/sustainability\\_reporting.html](http://www.sustainabledevelopment.in/services/corporate_sustainability_management/actities/sustainability_reporting.html)

### **Additional information (if any)**

**Student responsibilities: attendance as per University rules**

### **Course Reviewers:**

Dr. Yogendra Chaudhry, EPt. Head, Centre for Sustainable Development Westland Consulting, Ketek Group Inc,Canada & Chair, Public Education Division at Air and Waste Management Association,US.  
 Dr. Ambika Zutshi, Associate Professor , Faculty of Business and Law, Deakin University

|   |  |  |                           |          |
|---|--|--|---------------------------|----------|
| <b>Course title:</b> Advanced Logistics & Supply Chain Management   |  |  |                           |          |
| <b>Course code:</b>   | <b>No. of credits:</b> 2   | <b>L-T-P distribution:</b> 20-8-0                  | <b>Learning hours:</b> 28 |          |
| <b>Pre-requisite course code and title (if any):</b>  |  |  |                           |          |
| <b>Department:</b> Department of Business Sustainability  |  |  |                           |          |
| <b>Course coordinator (s):</b> Prof Shri Prakash  |  | <b>Course instructor (s):</b> Mr. Sanjeeva Shivesh |                           |          |
| <b>Contact details:</b> shivesh@entrepreneurship.edu.in   |  |  |                           |          |
| <b>Course type</b>  | Elective   | <b>Course offered in:</b> 3 <sup>rd</sup> Semester |                           |          |
| <b>Course description</b>   |  |  |                           |          |
| <p>This course develops upon the basic foundations of logistics and supply chain concepts to provide deeper understanding concepts, frameworks and tools for advanced analysis of logistics and supply chain design and deployment in complex organizations. The key areas where the course delves into deeper details are:</p> <ul style="list-style-type: none"> <li>- Inventory Planning</li> <li>- Demand Forecasting</li> <li>- Facility Planning and Network Design</li> <li>- Logistics and Supply Chain Strategy</li> </ul> <p>The course provides for a Capstone Consultancy Project, where students shall work with real organizations to work on their business problems using the concepts learnt in this course.</p> |  |  |                           |          |
| <b>Course objectives</b>  |  |  |                           |          |
| <ul style="list-style-type: none"> <li>▪ Understand and appreciate advanced concepts of logistics and supply chain management</li> <li>▪ Learn the art of inventory management and demand forecasting</li> <li>▪ Gain ability to design logistics networks and fulfilment centres</li> <li>▪ Display competence in solving real-life problems of logistics and supply chain</li> </ul>  |  |  |                           |          |
| <b>Course content</b>   |  |  |                           |          |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>   | <b>T</b>                  | <b>P</b> |
| 7.  | <b>Module 1: Advanced Concepts in Logistics and Supply Chain</b><br>Overview of Logistics and Supply Chain Concepts, SCOR Model and Integrated Supply Chain, Supply Chain and Shareholder Value, Ecommerce Supply Chains,  | 2  | -                         | -        |
| 8.  | <b>Module 2: Inventory Planning</b><br>Inventory Planning and Control Concepts such as Safety Stock, Reorder level, Economic Order Quantity, Economic Batch Quantity, Impact of multi-echelon supply chain on EOQ – Forrester Effect, Burbidge Effect, Flywheel Effect, Demand amplification and Bullwhip Effect, Service Level and Inventory Optimization   | 3  | 2                         | -        |
| 9.  | <b>Module 3: Demand Planning and Forecasting</b><br>Introduction to Demand Planning, Structured forecasting methods, Top Down and Bottom Up, Forecasting Bias, Time Series Analysis, Smoothing, Causal Analysis, Challenge of Organization setup in forecasting, Collaborative Planning, Forecasting and Replenishment (CPFR)<br>Case Study – Forecasting a New Project in a dynamic environment                       | 3  | 2                         | -        |
| 10.   | <b>Module 4: Facility Planning for Logistics</b><br>Depots, Warehouse, Fulfilment and Distribution Centres in Logistics, Designing the fulfilment centre operations, Designing the distribution centre operations, Locating the Fulfilment and Distribution Centres, Managing transshipment, Material handling equipment at Logistics Parks, Planning the Logistic Park Operations, Visit to Multimodal Logistics Park | 3  | 2                         | -        |
| 11.   | <b>Module 5: Supply Chain Network Modelling</b><br>Designing the supply chain network plan, Time-Resource Plan, Control Charts for Logistics Operations, Volume-Variety – Variability Challenge  | 3  | -                         | -        |
| 12.   | <b>Module 6: Developing the Logistics and Supply Chain Strategy</b>  | 2  | 2                         | -        |

|  |  |           |          |          |
|--|--|-----------|----------|----------|
|  | Strategic Frameworks for Logistics and Supply Chain, SCOR Model and its linkage to Business Strategy, Reverse Logistics, Situation Assessment and Gap Analysis<br>Consultancy Project on Logistics and Supply Chain (includes Approaches to solving supply chain challenges, Interviewing Top Management for understanding strategic issues and Project Presentations) |           |          |          |
| 13.  | <b>Module 7: Global logistics</b><br>Role of efficient global logistics for international trade, operational factors and strategic issues  | 2         | -        | -        |
| 14.  | <b>Module 8: Logistics information system (LIS)</b><br>Logistics information needs, Characteristics of LIS and Designing logistics information system  | 2         |          |          |
|  | <b>Total</b>   | <b>20</b> | <b>8</b> | <b>-</b> |
| <b>Evaluation criteria</b>   |  |           |          |          |
| <ul style="list-style-type: none"> <li>▪ Test 1: Mid-Term Examination 30%</li> <li>▪ Test 2: Assignment 30%</li> <li>▪ Test 3: End-term Examination 40%</li> </ul>   |  |           |          |          |
| <b>Learning Outcomes</b>   |  |           |          |          |
| <ul style="list-style-type: none"> <li>▪ Ability to understand and analyze advanced concepts of logistics and supply chain management, particularly inventory management and demand forecasting (Test 1 and 3)</li> <li>▪ Ability to design logistics networks and fulfilment centres and competence in solving real-life problems of logistics and supply chain will be evaluated by assignment (Test 2)</li> </ul>   |  |           |          |          |
| <b>Pedagogical approach</b>  |  |           |          |          |
| A combination of class-room interactions and assignments with special emphasis on case studies and real-life examples.   |  |           |          |          |
| <b>Reading Materials</b>   |  |           |          |          |
| <ol style="list-style-type: none"> <li>1. Logistics Management, The Supply Chain Imperative (Third edition), by V. V. Sople, Pearson India Education Services Private Limited, 2013</li> <li>2. Business Logistics/ Supply Chain Management. Planning, Organising and Controlling Supply Chain (Fifth edition), by Ronald H. Ballou and Samir K. Srivastava, Pearson India Education Services Private Limited, 2016</li> <li>3. Other relevant material, learning packs and case studies will be given in the class</li> </ol> |  |           |          |          |
| <b>Additional information (if any)</b>   |  |           |          |          |
| <b>Student responsibilities</b>  |  |           |          |          |
| Attendance, feedback, discipline, guest faculty etc.   |  |           |          |          |

**Course reviewers:**

1. Dr. Aswani Kumar Upadhyay, GM, Centre for Railway Information System (CRIS)
2. Mr Anil Gupta, Former Chairman & Managing Director, Container Corporation of India

| <b>Course title: Design Thinking</b>  |   |  |                           |          |
|---|---|--|---------------------------|----------|
| <b>Course code: BSI xxx</b>   | <b>No. of credits: 2</b>  | <b>L-T-P: 10-18-0</b>                      | <b>Learning hours: 28</b> |          |
| <b>Pre-requisite course code and title (if any): NA</b>   |   |  |                           |          |
| <b>Department:</b> Department of Business and Sustainability  |   |  |                           |          |
| <b>Course coordinator:</b> Dr. Akash Sondhi   |   | <b>Course instructor:</b> Dr. Akash Sondhi |                           |          |
| <b>Contact details:</b> akash.sondhi@terisas.ac.in  |   |  |                           |          |
| <b>Course type:</b> Open Elective   |   | <b>Course offered in:</b> Semester 3       |                           |          |
| <b>Course Description</b><br>This course will be an introduction to Design Thinking (DT). This course will let the learners understand the underpinnings of design thinking, and work with the DT framework and tools to help them understand design thinking as a creative problem solving approach. We will also explore unique stories from organizations and teams that used design thinking to uncover compelling solutions. |   |  |                           |          |
| <b>Course objectives</b><br>The course aims to:<br>Instil the Design Thinking approach<br>Develop the understanding and implementation of Design Thinking framework<br>Apply Design Thinking tools to solve a problem<br>Conceive and ideate persuasive solutions using Design Thinking approach.   |   |  |                           |          |
| <b>Course Content</b>   |   |  |                           |          |
| <b>S No</b>   | <b>Topic</b>  | <b>L</b>                                   | <b>T</b>                  | <b>P</b> |
| 1.  | <b>Problem Solving</b><br>Visual problem solving<br>Experience economy and the context of Digital   | 2  | 2                         | 0        |
| 2.  | <b>Design Thinking Philosophy</b><br>The three lenses of Innovation<br>Why Design thinking<br>Rudiments of Design Thinking  | 2  | 2                         | 0        |
| 3.  | <b>Design Thinking Framework and Tools</b><br>Five (5) phases of Design Thinking Framework<br>Design Thinking Framework: Empathy, Define, Ideate, Test, Prototype<br>Design Thinking Tools: Storyboarding, Build Measure Learn Feedback<br>DIY: Design Thinking Tools   | 2  | 3                         | 0        |
| 4.  | <b>Design Thinking Experience</b><br>Problem identification in the context of the Design Thinking Framework.<br>Problem Identification<br>DIY – Design Thinking Process<br>Empathy, Define, Ideate, Test, Prototype<br>Blog: DT Phases to solve a problem.  | 1  | 4                         | 0        |
| 5.  | <b>Design Thinking in Practice</b><br>Design Thinking Solution Working as teams of four (4) they will work on aspects of using DT with appropriate tools to solve the problem.<br>Design Thinking for Business Sustainability, Product, Service, Consultancy and Social Domains<br>DIY – Design Thinking Process for the Proposed problem | 2  | 3                         | 0        |
| 6.  | <b>Design Thinking Unique Case Studies</b><br>Group Presentation: Minimum Viable Product for the proposed problem<br>The Way Forward  | 1  | 4                         | 0        |
|   | <b>Total</b>  | <b>10</b>                                  | <b>18</b>                 |          |
| <b>Evaluation criteria</b><br><b>Test 1</b> Quiz (Module 1, 2 and 3): (30%) end of module 3<br>Test 1 will be a paper based exam which with multiple option questions and descriptive questions. The exam will evaluate the student understanding on the Design Thinking Approach, Philosophy, Framework and  |   |  |                           |          |



Tools.

**Assignment** - Blog (Individual + Group) (Module 3 and 4):15% (assigned at the beginning of module 2 and will evolve of the course duration)

The Design Thinking blog component is equivalent to the assignment and will be evaluated by the course coordinator. The blog creation assignment will be. The blog will be based on application of Design Thinking Framework and Tool and will be document a DT experience, the blog will be evaluated on process, inferences, creativity, clarity. This blog will be hosted in the blog website “Medium” and will remains as an artefact in the web domain for future evolution.

**Test 2** Group Presentation: Problem in Context with DT Phases (Module 3 and 4): 20% will be conducted during module 4

The group presentation component will be evaluated by the course coordinator (40 %), an external faculty (40 %) from the department of business studies, and peer evaluated (20%).

**Test 3** DT Use Case (Minimum viable Product Unique Case) (Module 5 and 6): 35% will be conducted during module 6.

Each team will create a present and submit a use case: a minimum viable product they developed for their problem using design thinking The final presentation minimum viable product and report submission will be assessed by a three-member panel, course coordinator (50 %), internal observer and an external faculty (30 %) (course reviewer / industry domain expert). A peer contribution component will be a part of the individual assessments.

#### **Learning outcomes:**

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

1. conceive and articulate the Design Thinking approach
2. contextualize a complex problem in the purview of Design Thinking
3. ideate solution based on the Design Thinking framework
4. create and present a unique solution based on Design Thinking

**Pedagogical Approach** – The course will be delivered through lectures, Interactive and experiential learning will be enabled by brainstorming, Case studies, Group Discussion, Videos, and Audio. Visual problem solving is an important part in Design Thinking, the course will use, Post it Notes (Mix Colour) methods to accomplish this.

#### **Materials**

##### **Books**

Required text: Liedtka, J. and Ogilvie, T. (2011). Designing for Growth – a Design Thinking Toolkit for Managers. Columbia Business School Publishing

##### **Compulsory Readings**

- Design Thinking for the Greater Good: Innovation in the Social Sector by Jeanne Liedtka (Columbia Business School Publishing) Hardcover – September 5, 2017
- The Back of the Napkin (Expanded Edition): Solving Problems and Selling Ideas with Pictures by Dan Roam Paperback – February 26, 2013
- Design Thinking 101, Sarah Gibbons, 2016, <https://www.nngroup.com/articles/design-thinking/>
- Brown Tim, (2008) Design Thinking, Harvard Business Review
- Liedtka Jane, The Essential Guide to Design Thinking - Generate new solutions with design thinking: a problem-solving process that combines creative and analytical thinking, E-Book, Darden Executive Education, University of Virginia.
- Cross Nigel, Design Thinking: Understanding How Designers Think and Work, Link: <https://books.google.co.in/books?id=F4SUVT1XCCwC&lpg=PT5&ots=7PTAzYVs0j&dq=Design%20Thinking&lr&pg=PT22#v=onepage&q=Design%20Thinking&f=false>

##### **Weblinks**

- Designit - <https://www.designit.com/>

- Mind Tools : <https://www.mindtools.com/pages/article/design-thinking.htm>

**Additional information (if any)**

**Recommended Audit of Course** – Design Thinking for the Greater Good: Innovation in the Social Sector  
<https://www.coursera.org/learn/uva-darden-design-thinking-social-sector/home/welcome>

**Student responsibilities**

The students are expected to submit assignments and all evaluation component within the timelines and come prepared with readings when provided. Attendance and Participation in Group Presentation sessions is mandatory, and course feedback is obligatory.

**Course reviewers**

1. Dr. Gerrit De Waal, Department of Management, RMIT University, Melbourne City Campus.
2. Mr. Shashank Deshpande, Chief Design Officer, Globant India, Pune
3. Mr. Praveen Bhond, Agile Consultant, Pune

|  |   |   |                           |          |
|--|---|---|---------------------------|----------|
| <b>Course title: SOCIAL ENTREPRENEURSHIP</b>   |   |   |                           |          |
| <b>Course code:</b>  | <b>No. of credits: 2</b>  | <b>L-T-P:16-12-0</b>                            | <b>Learning hours: 28</b> |          |
| <b>Pre-requisite course code and title (if any):</b>   |   |   |                           |          |
| <b>Department:</b> Social Entrepreneurship   |   |   |                           |          |
| <b>Course coordinator:</b> Dr Sapna A Narula   |   | <b>Course instructor:</b> Dr Avijit Chakravarti |                           |          |
| <b>Contact details:</b> avijitjournalist@gmail.com   |   |   |                           |          |
| <b>Course type:</b> Elective   |   | <b>Course offered in:</b> Semester 3            |                           |          |
| <b>Course description:</b><br>The proposed course will aim to sensitize students on the concept and practices of social entrepreneurship. Besides introducing students to the concept, the course will enable them to ideate, work on intent clarity, discover and also prepare an elementary business plan. In other words, it's a course based on the philosophy of Learning by Doing.   |   |   |                           |          |
| <b>Learning objectives:</b><br>The main objective of this course is to create a group of future students and professionals who can –<br>Appreciate the need for creating a self-driven and reflective journey towards understanding the relevance of using entrepreneurship as a tool to solve social problems<br>Understand and apply the tools of Value Proposition Design, Business Model Canvas and Effective Presentations to develop social entrepreneurial initiatives. |   |   |                           |          |
| <b>Course content:</b>   |   |   |                           |          |
| <b>S<br/>N<br/>o</b>   | <b>Topic</b>  | <b>L</b>  | <b>T</b>                  | <b>P</b> |
|  | <b>Dynamics of Development: The Indian Perspective</b><br>An Overview of the Development Sector<br>Focus on the Global and Indian Development Discourse<br>Ideology Versus Action<br>NGOs, Social Enterprises and Community-based Organizations | <b>4</b>  |                           |          |
|  | <b>Social Entrepreneurship</b><br>Case Studies of Social Enterprises in the Global and Indian Context   | <b>4</b>  |                           |          |
|  | <b>Advocacy and Social Marketing</b><br>A Perspective on Social Communication, Media and Marketing  | <b>2</b>  |                           |          |
|  | <b>Social Impact</b><br>An Introduction to Qualitative and Quantitative Social Research; Understanding Indicators; Baseline Studies, Mid-Term Reviews and Impact Assessments  | <b>2</b>  | <b>2</b>                  |          |
|  | <b>Clarify Intent</b><br>Understanding Self in Context of Social Entrepreneurship<br>Personal Business Model Canvas<br>Problem Identification<br>Matching Self and Challenge  | <b>1</b>  | <b>2</b>                  |          |
|  | <b>Innovate Concepts</b><br>Discovery<br>Value Proposition Design<br>Financial Model Preparation<br>Business Model Generation<br>Social Business Model  | <b>1</b>  | <b>4</b>                  |          |



Fortune at the Bottom of the Pyramid by CK Prahlad  
Case Studies (Grameen Bank, Narayana Hridayalaya)  
Lessons from real social enterprises (ACT, Slam Out Loud, Teach for Green, SaanjhiTokri,  
Changing Concern into Action, Kaitley, Mind Pipers, Muskaan etc.)  
Additional Readings, Case Studies and Research Papers will be suggested from time to time  
in the class

**Student responsibilities**

The students are expected to freely ask unconventional questions in the class and seek for solutions to those questions. They should actively work with their business model canvases and develop good presentations of their business plans.

**Course Reviewers**

Tushar Sankar Banerjee, BIMTECH  
Vinod Kumar, IMI New Delhi

|  |  |  |   |          |
|--|--|--|---|----------|
| <b>Course Title:</b> Corporate Social Responsibility   |  |  |   |          |
| <b>Course code:</b> PPM  | <b>No. of credits:</b> 2   | <b>L-T-P:</b> 20-08-00                             | <b>Learning hours:</b> 28                       |          |
| <b>Pre-requisite course code and title (if any):</b> NA  |  |  |   |          |
| <b>Department:</b> Department of Business and Sustainability   |  |  |   |          |
| <b>Course coordinator (s):</b> Dr. Sapna A Narula  |  |  | <b>Course instructor (s):</b> Dr Sapna A Narula |          |
| <b>Contact details:</b>  |  |  |   |          |
| <b>Course type</b>   | Core   | <b>Course offered in:</b> 2 <sup>nd</sup> Semester |   |          |
| <b>Course description</b>  |  |  |   |          |
| <p>There is no denying that Corporate Social Responsibility (CSR) has gained widespread acceptance within the business community (Freeman, 1984; Carroll, 1991) as a result of pressure from primary and secondary (or internal and external) stakeholders. There are a number of interpretations of the term social responsibility; nevertheless, it is commonly understood to be the obligation of decision makers to take actions which protect and improve the welfare of society whilst achieving their own interests. The definitions of CSR are abound. For instance, World Business Council for Sustainable Development (WBCSD, 2000, p. 3) defines “Corporate social responsibility [as] the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as local community and society at large”. Since CSR was mandated as part of the Companies Act 2013 for select organizations, an increasing number of Indian companies are drawn towards making CSR investments in a planned manner. Companies are also conscious of the impact of their investment in terms of community development and corporate reputation. Maximizing the impact of investments require that CSR is dealt with specifically trained human resource. It is one of the skills required especially for MBA (Business Sustainability) as many of them go for CSR profiles. The fact that there is a rise in demand of CSR professionals in India backs the rationale for introduction of a separate course.</p> |  |  |   |          |
| <b>Course objectives:</b>  |  |  |   |          |
| <p>The objectives of this course are to:</p> <p>Familiarize the students with understanding rationale and motivations behind CSR</p> <p>Enhance their understanding of CSR practices and initiatives of firms Equip them with conventional and contemporary theories of CSR</p> <p>Impart practical learning regarding design and implementation of CSR programmes</p> <p>Equip them with skills related to CSR strategy formation and evaluation</p>  |  |  |   |          |
| <b>Course content</b>  |  |  |   |          |
| <b>Module</b>  | <b>Topic</b>   | <b>L</b>   | <b>T</b>  | <b>P</b> |
| 7.   | <b>Introduction to CSR:</b><br>Definitions and Theories of CSR, Drivers of CSR,<br>The Business Case for CSR, Pyramid of CSR, CSR framework and Strategy, Creating Shared Value<br>Case: Four Case Studies on Corporate Social Responsibility: Do Conflicts Affect a Company’s Corporate Social Responsibility Policy?<br>Case: Tata Steel: A century of Corporate Social Responsibility   | 4  | -   | -        |
| 8.   | <b>Designing and Implementing CSR Programmes:</b><br>Need Mapping, prioritization, Roll-out of CSR Programmes; Structure, Systems, Roles and Responsibilities; Creating Local Partnerships, Implementing, evaluating and scaling up CSR to maximize shared value, Cross-sectoral Collaborations, Challenges in Implementing CSR<br>Case: Integrating and Implementing CSR: A Case of Concor in India<br>Case: CSR and sustainable Livelihoods: A Case Study of Bharat Coking Coal Ltd. | 8  | 4   | -        |
| 9.   | <b>Integrating CSR with Business :</b><br><br>CSR and Financial performance; Beyond Spending: CSR and Corporate Reputation; Creating impact in the community; Distinguishing strategic community involvement from sponsoring and philanthropy; Advanced  | 4  | 2   |          |

|  |  |           |          |          |
|--|--|-----------|----------|----------|
|  | involvement: Contributing corporate core competences; Employee volunteering as a strategic HR tool; Involving employees: Tools for motivating and activating; Embedding Socially responsible behavior in employees (corporate culture); CSR across supply chain, CSR in SMEs<br><br>Case: Tata Power: CSR and Sustainability<br>Case: Apple and its Suppliers: Corporate Social Responsibility |           |          | -        |
| 10.  | <b>Measuring and Reporting CSR</b><br>Corporate Social Performance, CSR Audit, Measuring CSR Impact, Impact assessment methodologies, CSR Communication, managing negative publicity and conduct related to CSR, Writing BRR (Business Responsibility Report)<br><br>Case: Genzyme's CSR Dilemma: How to play its hand?  | 4         | 2        | -        |
|  | <b>Total</b>   | <b>20</b> | <b>8</b> | <b>0</b> |
| <b>Evaluation criteria:</b><br>Following evaluation criteria will be adopted   |  |           |          |          |
| <ul style="list-style-type: none"> <li>▪ Test 1 : 20</li> <li>▪ Test 2 Case Analysis : 20</li> <li>▪ Test 3 Case Study Writing/Presentation : 20</li> <li>▪ Test 4 End Term Examination : 40</li> </ul>  |  |           |          |          |
| Case Study Writing (Group Assignment): The students will choose one case company (preferably Indian) and prepare a case study covering their CSR strategy, initiatives, planning and management and communication. The students are also expected to cover the drivers and challenges while implementing CSR by the company  |  |           |          |          |
| Case Analysis (Individual presentation): Students are required to present analysis of the cases assigned (No 4)  |  |           |          |          |
| <b>Learning outcomes:</b><br>At the end of the course, the students would have gained understanding of interrelationship between business, Government and Society and would be able to relate and describe multidisciplinary, strategic and evolving nature of CSR ( Test 1, Test 2)<br>organize, plan and manage CSR projects and communicate CSR activities of organization ( Test 2 and 3) conduct CSR audits and aid in making CSR strategy at the organizational level create shared value for business with society ( Test 2, 3, 4)  |  |           |          |          |
| <b>Pedagogical approach:</b> The course largely relies on case study based approach to learning. The case studies listed in the course outline would be discussed in all the modules. The students are expected to make presentations on the analysis of the cases. These will be preceded by theoretical presentations by the instructor in each module. The students would learn hands on training related to organizing, managing and implementing CSR projects through industry engagement and case study writing project. The students are encouraged to debate and discuss on various aspects of CSR planning and management from point of view of different stakeholders. Reading material (Listed in next section) for each module will be provided. |  |           |          |          |
| <b>Suggested Readings:</b><br>India CSR Reporting Survey, KPMG, 2017<br>Mervis, (2012) Employee Engagement & CSR: transactional, Relational and Development Approaches, HBS press<br>Marquis & Villa (2012) Managing Stakeholders with Corporate Social Responsibility, Harvard Business School Press.<br>Maines & Sprinkle (2010), The Benefits and Costs of Corporate Social Responsibility, HBS Press<br>Porter et al, 2007 Redefining Corporate Social Responsibility, HBS Press<br>Porter & Kramer (2006), Strategy & Society: The link between Competitive Advantage and Corporate Social Responsibility), HBS Press   |  |           |          |          |
| <b>Web References:</b><br>Amaeshi et al. (2007), Corporate Social Responsibility in Supply Chains of Global Brands: A  |  |           |          |          |

Boundaryless Responsibility? Clarifications, Exceptions and Implications, *Journal of Business Ethics*, 81, pp. 223–234.

Bauman, C.W. & Skitka, L.J. (2012), Corporate social responsibility as a source of employee satisfaction, *Research in Organizational Behavior* 32 (2012) 63–86.

Bloom, P.N. & Chatterji, A.K. (2009), Scaling Social Entrepreneurial Impact, *California Management Review* VOL. 51, NO. 3, 114-133.

Carrigan, E. and Mele, D. (2004), Corporate Social Responsibility Theories: Mapping the Territory, *Journal of Business Ethics*, 53, pp. 51–7

5. Carroll Archie B. and Shabana Kareem M. (2010), The Business Case for Corporate Social Responsibility: A Review of Concepts, Research and Practice, *International Journal of Management Reviews*, 85-105 DOI: 10.1111/j.1468-2370.2009.00275.x

Chandler, Robert (2007), Managing the risk of ethical misconduct disasters as a business continuity strategy, *Journal of Business Continuity & Emergency Planning*, 1(3), pp. 279 – 291.

Doorey, David J. (2011). The Transparent Supply Chain: from Resistance to Implementation at Nike and Levi-Strauss, *Journal of Business Ethics*, 103, pp. 587–603.

Du, S. & Viera Jr, E.T. (2012). Striving for Legitimacy Through Corporate Social Responsibility: Insights from Oil Companies. *Journal of Business Ethics*, 110(4), pp. 413-427.

Grigore, Georgiana F. (2011), "Chapter 3 Corporate Social Responsibility and Marketing", Güler Aras, David Crowther, in (ed.) *Governance in the Business Environment (Developments in Corporate Governance and Responsibility, Volume 2)*, Emerald Group Publishing Limited, pp. 41 – 58, [http://dx.doi.org/10.1108/S2043-0523\(2011\)0000002006](http://dx.doi.org/10.1108/S2043-0523(2011)0000002006).

0. Hunter, Samuel (2012). (Un)Ethical Leadership and Identity: What Did We Learn and Where Do We Go from Here? , *Journal of Business Ethics*, 107, pp. 79-87.

1. Jenkins, Heledd (2009), A ‘business opportunity’ model of corporate social responsibility for small and medium-sized enterprises, *Business Ethics: A European Review*, 18 (1), pp. 21-36.

2. Korschun, D. & Du, S. (2013), How virtual corporate social responsibility dialogs generate value: A framework and propositions, *Journal of Business Research*, 66(9), 1494-1504.

3. Lyon, Thomas P. & Montgomery, Wren, A. (2013). Tweetjacked: The Impact of Social Media on Corporate Greenwash, *Journal of Business Ethics*, 118, pp. 747–757

14. Tan, J. & Tan, A.E. (2012). Business Under Threat, Technology Under Attack, *Ethics Und Fire: The Experience of Google in China*. *Journal of Business Ethics*, 110(4), pp. 469-479.

15. Desore, A, Narula, S.A. & Zutshi, A. (2015); Sustainability Practices of Hotel industry in Corporate Social Performance: Paradoxes, Pitfalls and Pathways for a Better World (Ed. Agata Stachowicz-Stanusch)

16. Thakur, A., Zutshi, A & Narula, S. A (2015). Integrating and Implementing CSR: A Case of Concor in India in *CSR in Developing countries: Towards a Development Oriented Approach* (Eds. Dima Jamali, Charlotte Karam & Michael Blowfield), Greenleaf Publishing

17. Subramaniam, N., Kansal, M. and Babu, S., 2017. Governance of mandated corporate social responsibility: Evidence from Indian government-owned firms. *Journal of Business Ethics*, 143(3), pp.543-563.

18. Muttakin, M.B. and Subramaniam, N., 2015. Firm ownership and board characteristics: Do they matter for corporate social responsibility disclosure of Indian companies? *Sustainability Accounting, Management and Policy Journal*, 6(2), pp.138-165.

#### Additional information (if any)

**Student responsibilities:** Attendance, feedback, discipline: as per university rules

#### Course reviewers:

Dr. Rajat Panwar, Associate Professor (Sustainable Business Management) Appalachian State University, US

Dr. Nava Subramanian, Director, Centre for Business, Law and Accounting, RMIT University, Australia

Dr. Ambika Zutshi, Associate Professor, Deptt of Management, Deakin University, Australia

Mr. Abhishek Ranjan, Associate Director (Marketing & CSR), Brillio Technologies, Bangalore & Advisor CSR, FKCC



| <b>Course title:</b> Business, Natural Ecosystems and Community   |  |                          |  |                           |
|---|--|--------------------------|--|---------------------------|
| <b>Course code:</b> PPM 182   |  | <b>No. of credits:</b> 2 | <b>L-T-P:</b> 20-08-00                         | <b>Learning hours:</b> 28 |
| <b>Pre-requisite course code and title (if any):</b> NA   |  |                          |  |                           |
| <b>Department:</b> Business & Sustainability  |  |                          |  |                           |
| <b>Course Coordinator:</b> Dr.Sapna A. Narula   |  |                          | <b>Course instructors:</b> Dr. Sapna A. Narula |                           |
| <b>Course type:</b> Core  |  |                          | <b>Course offered in:</b> 3 Semester           |                           |
| <b>Course Description:</b><br>Biodiversity and ecosystems are increasingly being recognized as critical natural resource and business issues as geographical areas selected by organizations as a source of materials or supplies are relied upon at an operational level and impact business decision making. There may also be non- financial costs that warrant recognition and measurement, with reference to water scarcity issues and knock on impacts of industrial production on other local industries such as farming or fishing. However, there are other impacts on natural resources which need immediate attention in context of business dependencies and community development. The course explores the drivers, regulatory pressures, frameworks and, most significantly, the business case for ecosystem service measurement and management and social issues associated with it. |  |                          |  |                           |
| <b>Course objectives:</b><br>To equip business management students with the skills they need to better manage the impacts and dependencies on ecosystems and services that they provide<br>To make them understand the relationship of businesses with local communities and learn to devise strategies for community relationship and engagement   |  |                          |  |                           |
| Course contents   |  |                          |  |                           |
| Module  | Topic  | L                        | T  | P                         |
| 1   | <b>Introduction to Ecosystems and its Services</b><br>Introduction to Ecosystems: Structure and functioning; Ecosystems Services, Assessing changes in ecosystem Services, Business Case for Action (Risk Assessment); Business Initiatives in Ecosystem Management; Business- Community-Ecosystems Interface Case studies-Steel, Mining, Cement.  | 4                        | 0  | 0                         |
| 2   | <b>Identifying Ecosystem Impacts and Dependencies</b><br>Introduction to Corporate Ecosystems Services Review; Tools, Framework and Methodologies (Water Footprint, GHG Footprint, Stakeholder Engagement Tools, Life-Cycle tools)<br><br><b>Corporate Ecosystem Valuation</b><br>Business Case for Valuation of Ecosystems, Screening for Corporate Ecosystem Valuation; The Economics of Ecology and Biodiversity, CEV Tools and Methodologies (InVest Integrated Valuation of Ecosystem Services and Trade-offs), Decision-making tools (MLSA software), Applying Corporate Ecosystem Valuation, Using CEV for improving business performance, Market for Ecosystem Services (Direct payments, Tradable Limits, Certifications) | 8                        | 4  | 0                         |

|   |  |    |   |   |
|---|--|----|---|---|
| 3 | <b>Natural Ecosystems and Business Applications</b><br>Forests and Community, Forest Based Industries, Utilization of Non-Timber Forest Products and role of businesses, Community and Social Forestry, Forest and Livelihoods. REDD+; Businesses and Aquatic/wetlands Ecosystems<br>Case Study: NTFP based Livelihood Development in Dhenkanal Distt of Odisha. | 4  | 2 | 0 |
| 4 | <b>Engaging with Communities</b><br>Impact assessment of Business Projects, Community Engagement and Management, Relocation and Rehabilitation, Sustainable Livelihood Development, Socially responsible Business Models for Community Development   | 4  | 2 | 0 |
|   | <b>Total</b>   | 20 | 8 | 0 |

**Evaluation criteria:**

The evaluation criteria of the course aim at testing the practical skills learnt during the course duration.

Test 1: Test 1 will consist of case studies / questions on theoretical concepts

Test 2 Case Studies (Group presentations): The students shall be asked to prepare analysis of the cases assigned and present in the class.

Test 3 Field assignment (Group presentations): Students are encouraged to conduct a field visit to suitable locations to study business impacts and dependencies of various industries on ecosystems such as mining, textile, cement, real-estate or any other. The students would then apply the skills learnt during the course to solve business problems related to ecosystems. The presentation and the concept note may be prepared based on the field visit and followed by the field visit report.

|   |     |
|---|-----|
| Test 1                                    | 20% |
| Test 2 Case Studies (Group presentations) | 40% |
| Test 3 Field Assignment                   | 40% |

**Learning outcomes:**

By the end of the course, the students will:

Develop an understanding of business impacts and dependencies on ecosystems, the ecosystem services and their sustainable use. (Test1 and 2)

Learn tools and techniques of Corporate Ecosystem Review and Valuation (Test 1, 2 and 3)

Learn to devise strategies for community engagement and management (Test 2 and 3) Develop an ability to handle both operational and strategic business problems related to both risk assessment and management with respect to impacts on Ecosystems and Communities (Test 3).

**Pedagogical approach:**

The course largely relies on case study-based approach to learning. Around eight case studies listed in the course outline would be discussed. The students would learn hands on training related to tools, frameworks and techniques of Corporate Ecosystem Valuation, Stakeholder Engagement and, Social Impact assessment. The students are encouraged to debate and discuss on various aspects of community relationship management and come out with their reports and give presentations on various facets of socially responsible business models involving community initiatives. There will be a field visit to study the business impacts on ecosystems and communities. Reading material (Listed in next section) for each module will be provided.

**Suggested Readings: Suggested Readings**

Ecology and Equity: The Use and Abuse of Nature in Contemporary India Author(s): Madhav Gadgil and Ramachandra Guha

Looking Back to Change Track (New) Editor: Divya Datt and Shilpa Nischal, Year:2010, TERI Press , Forest Policy & Law - Applied Forestry Series No 1 by S S Negi.

**Other References:**

Guide to Corporate Ecosystem Valuation: A framework for improving corporate decision-making (WBCSD, 2013)

Corporate Ecosystem Valuation (CEV) Guidance (WBCSD, 2013)

Corporate Ecosystem Valuation: A scoping study(WBCSD,2013)

Ecosystem services and biodiversity tools to support business decision-making (WBCSD,2013)

Introduction to Valuing Ecosystem Services (WBCSD,2013)

Connecting the dots: Nexus between ecosystem and business(WBCSD,2013)

Approach for reporting on ecosystem services: Incorporating ecosystem services into an organization's Performance disclosure (GRI)

Corporate Value Chain (Scope 3) Accounting and Reporting Standard (WBCSD,2013)

Business, Ecosystems, and Biodiversity: New Horizons for Management Research (WBCSD,2013)

How Business Values Natural Capital: Taking Stock and Looking Forward (WBCSD,2013)

Responding to the biodiversity challenge: Business contributions to the Convention on Biological Diversity (WBCSD)

Biodiversity and ecosystem services scaling up business solutions: Company case studies that help achieve global biodiversity targets (WBCSD)

Ecosystem services and biodiversity tools to support business decision-making (WBCSD)

The Corporate Ecosystem Service Review (WBCSD)

GRI inside and out: Global Reporting Initiative (GRI)

Annual Report(PUMA, 2016)

Markets for Ecosystem Services – New Challenges and Opportunities for Business and the Environment: *A Perspective* (IUCN)

Corporate Ecosystem valuation: Building the business cases (WBCSD,2013)

How to Value Ecosystem Impacts and Opportunities: *Guide to Corporate Ecosystem Valuation road tested* (WBCSD,2013)

Responding to the Biodiversity Challenge Business contributions to the Convention on Biological Diversity

Making Sustainable Living Commonplace: Unilever Strategic Report: Annual Report and Accounts (Unilever)

Narula, S.A. and Bhattacharyya, S., 2017. Off-grid Electricity Interventions for Cleaner Livelihoods: A Case study of Value Chain Development in Dhenkanal District of Odisha. *Journal of Cleaner Production*, 142, pp.191-202.

Magray, M.A., Narula, S.A & Anwer, R.: Scope of Lac as Enterprise Development in Jharkhand; *Indian Journal of Economics and Development*, (2017), 13 (2), 387-39

Narula, S. A, Magray, M.A and Desore, A. (2017), A sustainable livelihood framework to implement CSR project in coal mining sector; *Journal of Sustainable Mining*, (2017), 16(3), 83-93

**Student responsibilities:** Attendance, feedback, discipline: as per university rules.

**Course Reviewers:**

Prof. Brajesh Singh, Director, Global Centre for Land based Innovation, Hawkesbury Institute for Environment, University of Western Sydney, Australia

Dr. Rajat Panwar, Associate Professor (Associate Professor (Sustainable Business Management) Appalachian State University, US.

Ms. Kanchi Kohli: Legal Research Director, Namati Environment Justice Program Centre for Policy Research, New Delhi

| <b>Course Title:</b> Urban Governance   |  |                                     |                           |   |
|---|--|-------------------------------------|---------------------------|---|
| <b>Course Code:</b> MEU 169   | No. of Credits: 3  | <b>L-T-P:</b> 34-8-0                | <b>Learning hours:</b> 42 |   |
| <b>Pre-requisite course code and title (if any):</b> None. However, a basic knowledge of civics and understanding of political processes will be useful.  |  |                                     |                           |   |
| Department: Energy and Environment  |  |                                     |                           |   |
| Course coordinator: Dr Abhijit Datey  |  | Course instructor: Dr Abhijit Datey |                           |   |
| Contact details: abhijit.datey@terisas.ac.in  |  |                                     |                           |   |
| Course Type: Core   |  |                                     |                           |   |
| <p><b>Course description:</b> Governance assumes great significance in the context of urban development and management. This course is intended to equip students not from a legal background with a basic understanding of the law and policy related to the governance of cities and the process of urbanisation in India. It looks at urban governance through four main themes: administration, planning, environment and citizenship, and is divided into five modules.</p> <p>The course opens with an introductory module covering the basics of the Indian legal system, an overview of urban governance in India, and the Constitutional foundations of urban local bodies. The next module provides an overview of the legal and administrative framework dealing with the creation, composition, powers and functions of these bodies, with an emphasis on their role in decentralised democratic governance and not merely as providers of urban services. The third module looks at urban planning as a legal function, and its role in maintaining State control over urbanisation as a process. This module also focuses on the role of informal systems and processes that exist outside formal urban planning, and how their relative fluidity plays an important role in the growth of cities. This is followed by a module examining environmental laws and processes in the context of urban issues.</p> <p>The course closes with a module on urban citizenship, which looks at how regulatory processes affect different classes of the city's residents and the kind of recognition the law accords to them. Drawing on earlier parts of the course, this module will use livelihood, housing, and public order to illustrate how despite formal equality before the law, planning and administrative processes have tended to push the urban poor to the margins of cities. At the end of the course, students will examine to what extent the ideals of decentralised democratic urban governance enshrined in the Constitution have translated into practice.</p> |  |                                     |                           |   |
| <b>Course objectives:</b>   |  |                                     |                           |   |
| <ol style="list-style-type: none"> <li>1. Introducing students to the laws, policies and institutions governing Indian cities.</li> <li>2. Enabling students to understand processes and structures of urban administration in India.</li> <li>3. Equipping students with the skill to analyse legal and policy documents and their application to projects.</li> <li>4. To enable students to develop critical understanding of laws vis-à-vis issues of inclusiveness.</li> </ol>   |  |                                     |                           |   |
| <b>Course contents</b>  |  |                                     |                           |   |
| Sl. No.   | Topic  | L                                   | T                         | P |
| <b>Module I:<br/>Introduction</b>   | <b>A. Introduction to the Constitution of India and the Indian legal system</b> <ul style="list-style-type: none"> <li>• Federal structure, three tiers of government</li> <li>• Fundamental rights; Directive Principles of State Policy</li> <li>• Legislation: Parliament and State Legislatures; Acts and Rules; Difference between law and policy</li> <li>• Judicial remedies: High Courts and Supreme Court</li> </ul> <i>Constitution of India: Articles 32, 226</i> | 3                                   | 1                         | 0 |
|   | <b>B. Introduction to Urban Governance in India</b>  |                                     |                           |   |

|                                      |   |    |   |   |
|--------------------------------------|---|----|---|---|
|                                      | <ul style="list-style-type: none"> <li>Global perspectives on decentralised governance and the history of the 74<sup>th</sup> Constitutional Amendment</li> <li>Overview of legislation on urban local bodies</li> </ul>  |    |   |   |
| <b>Module II:<br/>Administration</b> | <p><b>A. Institutions and processes</b></p> <ul style="list-style-type: none"> <li>Types of urban local bodies<br/><i>Constitution of India: Article 243-Q</i></li> <li>Composition of urban local bodies</li> <li>Elections and reservation; Councillors and wards<br/><i>Constitution of India: Articles 243-R, 243-T, 243-U</i></li> <li>Mayor in Council</li> <li>Standing Committee and other committees</li> <li>Municipal Commissioner and other officers</li> <li>Functions of urban local bodies</li> <li>Devolution of functions from state governments to urban local bodies<br/><i>Constitution of India: The Twelfth Schedule</i></li> </ul> <p><b>B. Finance</b></p> <ul style="list-style-type: none"> <li>Overview of Municipal Finances</li> <li>State Finance Commission</li> <li>Functionaries: municipal auditors and accountants<br/><i>Constitution of India: Articles 243-I, 243-Y</i></li> <li>Municipal Funds; Special Funds</li> <li>Municipal budgeting and sub-budgets</li> <li>Contracts and tenders</li> <li>Loans and borrowing powers</li> <li>Introduction to municipal taxation</li> <li>Property tax; classification and assessment of buildings</li> <li>Octroi; water, sanitation and other taxes<br/><i>Constitution of India: Articles 243-X, 265</i></li> </ul> <p><b>C. Public Participation</b></p> <ul style="list-style-type: none"> <li>Importance of participatory processes in democratic governance<br/>Wards Committees; Ward/Area Sabhas<br/><br/><i>Constitution of India: Article 243-S</i></li> <li>Smart Cities and public participation</li> </ul> | 10 | 2 | 0 |
| <b>Module III:<br/>Planning</b>      | <p><b>A. Regulation</b></p> <ul style="list-style-type: none"> <li>The importance of planning: “ideal” cities and the rule of law</li> <li>Role of the law in regulating development: formal and informal settlements</li> </ul> <p><b>B. Institutions and systems</b></p> <ul style="list-style-type: none"> <li>City development authorities and their functioning</li> <li>Town &amp; Country Planning Departments</li> <li>Para-statal and their relationship with other agencies</li> <li>Development Plans, Master Plans, Development Control Regulations</li> <li>Violations of the planned city</li> </ul>  | 10 | 2 | 0 |

|  |  |           |          |          |
|--|--|-----------|----------|----------|
| <b>Module IV:<br/>Environment</b>  | <b>A. Overview</b> <ul style="list-style-type: none"> <li>• Sources of Indian Environmental Law<br/><i>Constitution of India: Articles 21, 48A, 51A</i></li> </ul> <b>B. Institutions</b> <ul style="list-style-type: none"> <li>• Ministry of Environment, Forests and Climate Change</li> <li>• Central and State Pollution Control Boards</li> <li>• National Green Tribunal</li> </ul> <b>C. Environmental governance and the city</b> <ul style="list-style-type: none"> <li>• Polluter Pays; Sustainable development; Precautionary Principle.</li> <li>• Overview of Urban Water, Sanitation and Hygiene (WASH)</li> <li>• Discussion of Cases</li> </ul> | 8         | 2        | 0        |
| <b>Module V:<br/>Citizenship</b>   | <b>Understanding Right to the City and Planned Exclusions</b> <ul style="list-style-type: none"> <li>• Differing judicial responses to issues of the urban poor: slums, street vendors and the homeless</li> </ul>   | 3         | 1        | 0        |
|  | <b>Total</b>   | <b>34</b> | <b>8</b> | <b>0</b> |
| <p><b>Evaluation criteria:</b><br/> <b>Weightage (%)</b><br/> <b>Tests I and II :20%</b>, Small Assignments per week connected to lectures taken in the class (Individual, Written tests on theory, Assignments containing literature review and summarisation, Assignments are specifically linked to learning outcome 1 &amp; 3. The students would become comfortable reading laws, policies and understand their relevance in larger context of urban governance. They would also gain confidence in using such documents for analysis.)</p> <p><b>Project Work-I: 20%</b>, Duration of 1 month after first month of lectures (Individual, understanding comparative differences between state level legislations, this project is linked to learning objective-2, where the students would assess and evaluate differences between laws and policies and understand their working)</p> <p><b>Project Work-II: 20%</b>, Duration of 1 month after second month of lectures (Group, analysing any current urban problem and its solution from the perspective of law, linked to learning objective-4, student would learn the socio-political processes behind law formation and challenges and gaps of implementation)</p> <p><b>Test III :40%</b> (End of the semester)<br/> (Individual, Written exam, written exam is linked to all the four outcomes to test the comprehensive understanding of the subject and its linkage with various components of urban development and management)</p> |  |           |          |          |
| <p><b>Learning outcomes:</b><br/> On successful completion of this course, students will be able to:</p> <ol style="list-style-type: none"> <li>1. Understand various aspects of urban governance and the role of law and policy.</li> <li>2. Evaluate the functioning of laws, policies and institutions of urban governance from the perspective of democratic governance and other constitutional values.</li> <li>3. Gather basic understanding of legal documents and processes and documents and skills to read and use them for analysis.</li> <li>4. Appreciate the role played by socio-political processes in the implementation of law and policy.</li> </ol>   |  |           |          |          |
| <p><b>Pedagogical Tools:</b><br/> Lectures, Class level discussions, Exercises in reading, reviewing and summarising, Presentations</p>  |  |           |          |          |

**Mandatory reading:**

Bhan, G. (2009) “‘This is no longer the city I once knew’”. Evictions, the urban poor and the right to the city in millennial Delhi’, *Environment and Urbanization*, 21(1), pp. 127–142. doi: 10.1177/0956247809103009.

Bhuwania, A. (2017) *Courting the People: Public Litigation in Post Emergency India*. New Delhi: Cambridge University Press.

Centre for Policy Research (2015) *Categorisation of Settlement*. New Delhi. Available at: <http://www.cprindia.org/sites/default/files/policy-briefs/Categorisation-of-Settlement-in-Delhi.pdf>.

Chandra, A. and Jain, R. (2015) *Property Rights of Street Vendors*. Available at: <http://ccs.in/sites/default/files/research/research-property-rights-of-street-vendors.pdf>.

Donthi, P. (2014) ‘The Road to Gurgaon-How the brokers of land and power built the Millenium City’, *The Caravan*, July. Available at: <http://www.caravanmagazine.in/reportage/road-gurgaon>.

Heller, P. and Mukhopadhyay, P. (2015) *State-produced inequality in an Indian city*, *Seminar*. Available at: [http://india-seminar.com/2015/672/672\\_patrick\\_&\\_partha.htm](http://india-seminar.com/2015/672/672_patrick_&_partha.htm) (Accessed: 21 May 2018).

India. Ministry of Housing and Urban Poverty Alleviation (2007) *National Urban Livelihoods Mission-Mission Document*. New Delhi.

Mehra, D. (2012) ‘Protesting Publics in Indian Cities: The 2006 Sealing Drive and Delhi’s Traders’, *Economic & Political Weekly*, 47(30), pp. 79–88.

Mohanty, P. K., Misra, B. M., Goyal, R. and Jeromi, P. D. (2007) *Municipal Finance in India : An Assessment, DRG Studies Series*. 26. Mumbai: Department of Economic Analysis and Policy, Reserve Bank of India.

Mukhopadhyay, P. (2016) ‘Unsmart Cities’, *Live Mint*, 29 June.

Ram Mohan, M. P. and Dulluri, A. (2017) ‘Constitutional mandate and judicial initiatives influencing Water, Sanitation and Hygiene (WASH) programmes in India’, *Journal of Water Sanitation and Hygiene for Development*, 7(4), pp. 630–641. doi: 10.2166/washdev.2017.135.

Shah, P. J. and Bokore, M. (eds) (2006) *Ward Power-Decentralised Urban Governance*. New Delhi: Centre for Civil Society.

Sheikh, S. and Mandelkern, B. (2014) *The Delhi Development Authority accumulation without development, Cities of Delhi Project*. New Delhi: Centre for Policy Research. Available at: <http://citiesofdelhi.cprindia.org/wp-content/uploads/2015/03/Accumulation-without-Development.pdf>.

Sivaramakrishnan, K. C. (2014) *Governance of Mega-Cities: Fractured Thinking, Fragmented Setup*. Oxford University Press.

The World Bank (2008) *Decentralisation and local democracy in the world: First global report by United Cities and Local Governments*

**Further Reading:**

India Planning Commission (2012) *Report of the Working Group on Urban Governance*

Vaidya, C. (2009) *Urban Issues , Reforms and Way Forward in India, Economic Affairs*. 4/2009-DEA. India, Ministry of Finance.

**Suggested List of Legislations and Plans**

Mumbai Municipal Act 1888: sections 5-5A, 6-6B, 19,36-37, 38-50S, 54, 73A-78, 79, 61, 63-63A, 78A-78E, 111-138, 69-73, 106-106A,109, 50TT

Delhi Development Act 1957: sections 2-6,22,7-14

Water (Prevention and control of pollution) Act,1974

Air (Prevention and control of pollution) Act, 1981

National Green Tribunal Act, 2010

Environment Protection Act, 1986

Masterplan of Delhi, 2021

**Suggested List of Cases**

Relocation of Polluting Industries

*M.C. Mehta v. Union of India* (1987) S.C.R. (1)819

Art of Living Celebration

*Manoj Mishra v. DDA* (2012) N.G.T.

Pavement Dwellers

*Olga Tellis v. State of Bombay* (1985) S.C.C. (3)545

Jhuggi Jhopri(JJ) Cluster Rehabilitation

*Pitampura Sudhar Samiti v. Union of India* (2002)

Slum Eviction Process

*Sudama Singh v. NCT of Delhi* (2010)

Night Shelters in Delhi

*Court on its own motion v. NCT of Delhi* (2011)

Urban Homelessness

*E.R. Kumar v. Union of India* (2016)

Course Reviewers:

1. Dr. Usha Raghupathi, Professor, National Institute of Urban Affairs (NIUA), New Delhi
2. Dr. M.P. Ram Mohan, Professor, Indian Institute of Management (IIM), Ahmedabad



|  |  |  |                              |          |
|--|--|--|------------------------------|----------|
| <b>Course title: Introduction to Geographic Information System (GIS)</b>   |  |  |                              |          |
| <b>Course code:</b> MEU 175  | <b>No. of credits:</b> One   | <b>L-T-P:</b> 8-0-12                         | <b>Learning hours:</b><br>14 |          |
| <b>Pre-requisite course code and title (if any):</b> None  |  |  |                              |          |
| <b>Department:</b> Department of Energy and Environment  |  |  |                              |          |
| <b>Course coordinator:</b> Dr Nithiyanandam Y  |  | <b>Course instructor:</b> Dr Nithiyanandam Y |                              |          |
| <b>Contact details:</b> <a href="mailto:nithiyanandam.y@terisas.ac.in">nithiyanandam.y@terisas.ac.in</a>   |  |  |                              |          |
| <b>Course type:</b> Core   |  | <b>Course offered in:</b> Semester one       |                              |          |
| <p><b>Course description:</b> Geographic information system is one the major component of Geo-spatial technologies. Spatial data are becoming crucial and being part of everyday life, GIS help to collect, manage, analyse and produce output from spatial data in an efficient way. Today, GIS technology is not limited to mapping as before, and used in various fields for visualisation, spatial analysis, machine learning (including artificial intelligence), and decision making.</p> <p>This course is to introduce Geographic Information System and its applications to first semester students to apply knowledge of GIS in other courses offered.</p> |  |  |                              |          |
| <b>Objectives:</b>   |  |  |                              |          |
| This course aspires to:  |  |  |                              |          |
| <ul style="list-style-type: none"> <li>• Introduce basic concepts in GIS</li> <li>• Provide exposure to basic tools and techniques in GIS software</li> <li>• Introduce applications of GIS in relevant areas</li> </ul>   |  |  |                              |          |
| <b>Course content</b>  |  |  |                              |          |
| <b>S no</b>  | <b>Topic</b>   | <b>L</b>                                     | <b>T</b>                     | <b>P</b> |
| 1  | Evolution of cartography, Geographic Information System – definition, history, current trends and future, concepts and components of GIS, Big data in GIS, and other geospatial technologies.  | 2  | 0                            | 2        |
| 2  | Spatial data: Definition, VS Nonspatial data, types (raster and vector), characteristics, sources (including Bhuvan Geo-portal), creation, topology, and standards, Introduction to spatial data analysis. National level initiatives for creating spatial data infrastructure in India. | 4  | 0                            | 6        |
| 3  | Applications of GIS in urban: energy, environment and planning; case studies.  | 2  | 0                            | 4        |
|  | <b>Total</b>   | 8  | 0                            | 12       |
| <b>Evaluation criteria</b>   |  |  |                              |          |
| Test 1: 25%  |  |  |                              |          |
| Test 2: 50%  |  |  |                              |          |
| Practical: 25%   |  |  |                              |          |
| <b>Learning outcomes:</b>  |  |  |                              |          |
| Upon completion of this course, a fully engaged student will be able to:   |  |  |                              |          |
| <ul style="list-style-type: none"> <li>• Know the basic concepts in GIS</li> <li>• Work with basic tools in GIS software</li> <li>• Understand and manage spatial information</li> <li>• Apply GIS tools and techniques in related applications</li> </ul>   |  |  |                              |          |
| <b>Pedagogical approach:</b> Lectures, case studies discussion, hands-on exercises, and peer learning.   |  |  |                              |          |
| <p><b>Materials:</b></p> <p><b>a. Books</b></p> <p>Bhatta, B. (2011) <i>Remote Sensing and GIS</i>. OUP India.</p> <p>Burrough, P. A., McDonnell, R. A. and Lloyd, C. D. (2015) <i>Principles of Geographical Information Systems</i>. OUP Oxford.</p>   |  |  |                              |          |

Chang, K. (2015) *Introduction to Geographic Information Systems*. McGraw-Hill Education.  
 Ian, H. (2010) *An Introduction to Geographical Information Systems*. Pearson Education.  
 Longley, P. A. *et al.* (2010) *Geographic Information Systems and Science*. John Wiley & Sons.  
 Weng, Q. (2011) *An Introduction to Contemporary Remote Sensing*. McGraw-Hill Education.

**b. Journals references**

- Annals of GIS
- GeoInformatica
- International Journal of Digital Earth
- International Journal of Geographical Information Science
- Journal of Geographical Systems
- Journal of Spatial Science

**c. Magazines**

- Coordinates
- Geospatial world
- GIM International
- GIS development
- GIS World

**Others:**

Other online materials including case studies to be provided in due course of time.

**Additional information (if any)**

**Student responsibilities:**

The students are expected to read supplementary materials provided along with the course to get holistic knowledge about the subject. Further expected to complete practical exercises and assignments on time.

**Course reviewers:**

Prof Qihao Weng,  
 Director, Centre for Urban and Environmental Change;  
 Professor, Department of Earth & Environmental Systems,  
 Indiana State University, USA.

Prof Iyyanki,  
 Raja Ramanna, DRDO Distinguished Fellow, India;  
 Professor of Excellence, Chiba University, Chiba, Japan;  
 Adjunct Professor, Asian Institute of Technology.

Prof Nusret Demir,  
 Deputy Dean, Faculty of Science, Akdeniz University, Turkey.

**List of practicals:**

1. An Introduction to commonly used tools in ArcGIS software.
2. Working with Spatial data: Raster and vector data creation and importing spatial data.
3. Spatial data conversion and map making.
4. Working with Bhuvan – Indian Geo platform of ISRO.
5. Base map creation.
6. Preparing thematic layers for urban planning.

| Course title: Ecosystems and Climate Change  |  |                       |                          |                |          |
|--|--|-----------------------|--------------------------|----------------|----------|
| Course code:XXX  | No. of credits:<br>3                         | L-T-P<br>distribution | Learning hours : 27-12-8 |                |          |
| Pre-requisite course code and title (if any): Ecology in graduation or as a first semester course at TERI University.  |  |                       |                          |                |          |
| Faculty:   | Department : Department of Natural Resources |                       |                          |                |          |
| Course coordinator (s)   | Course instructor (s): S. Chatterjee         |                       |                          |                |          |
| Contact details: s.chatterjee@terisas.ac.in  |  |                       |                          |                |          |
| Course type  | Compulsory                                   | Core                  | Elective                 |                |          |
| Course offered in  |  | Semester              | Semester 3               | Other Semester |          |
| <p><b>Course Description:</b> The course has been designed for students pursuing MSc Climate Science and Policy. The modules of the course will apprise the students on the concept of ecosystems, their types and vulnerabilities to the impacts of climate change. Students will learn the tools for impact studies and get appraised with present level of national and global efforts in mitigation and adaptation strategies.</p> |  |                       |                          |                |          |
| <p><b>Course objectives:</b><br/>The objectives of the course shall be to learn</p> <ol style="list-style-type: none"> <li>1.The Science of Ecosystems, their evolutionary history, structure and functioning and linkages to climate.</li> <li>2. Study the known impacts of climate change of ecosystems, methods of monitoring and national and global initiatives on ecosystems and climate change.</li> </ol>                     |  |                       |                          |                |          |
| <b>Course content</b>  |  |                       | <b>L</b>                 | <b>T</b>       | <b>P</b> |
| <b>Module 1: Fundamentals of the concept of Ecosystem.</b>   |  |                       |                          |                |          |
| The evolution of the concept of ecosystem ecology, defining ecosystem, Concept of Primary Productivity. Energy flows in ecosystems.  |  |                       | 2                        |                |          |
| Gaia Hypothesis and the Daisy Model.<br>Class Discussion.  |  |                       | 1                        | 1              |          |
| The perspectives of Ecosystem Succession The Clements theory of climatic climax , Gleason theories of succession, Assembly Rules and their significance on climate change studies. .   |  |                       | 1                        |                |          |
| <b>Class discussion</b>  |  |                       |                          | 2              |          |
| <b>Module 2: Climate in Geological time periods.</b>   |  |                       |                          |                |          |
| Understanding of climate in Geological time scales and diversity of life, Precambrian to Phanerozoic.  |  |                       | 2                        |                |          |
| Natural History , Forests and wildlife in India through geological ages and Book Review  |  |                       | 2                        |                |          |
|  |  |                       |                          | 1              |          |
| <b>Module 3: Fundamentals of Climate- Ecosystem Linkages.</b>  |  |                       |                          |                |          |
| Terrestrial and Aquatic (Fresh Water and Marine), natural and manmade ecosystems responses to global warming with focus on species reported to   |  |                       | 2                        |                |          |

|   |  |           |          |
|---|--|-----------|----------|
| be vulnerable to Climate Change.<br><br>Global Vegetation Classification System. Life forms and Plant Functional types Essential Climate and Biodiversity Variables. A quantitative approach to vegetation – climate interaction, History of modelling impacts of Climate change on Vegetation.<br>Journal papers to work on.   | 4                                      | 2         |          |
| <b>Module 4: Global programmes/ initiatives on Ecosystem- Climate Change Research.</b><br>Contributions of Ecosystem approach of the International Biological Programme (IBP), The International Geophysical Year, REDD +Eight national missions of National Action Plan on Climate Change (NAPCC) with an emphasis on :<br>a.National Mission for Sustaining Himalayan Ecosystem (NMSHE); National b.Mission on Strategic Knowledge for Climate Change (NMSKCC).<br><br>Discussion on Initiatives under National Communication to United Nations Framework on Convention on Climate Change (UNFCCCC) | 4                                      | 2         |          |
| Ecosystems vulnerable to climate change identified in India. Studies in India on adaptations to climate change.<br>Discussion on a case study.  | 2                                      | 1         |          |
| Discussion on Case studies: Impact of Climate change on ecosystems and species.   |  | 2         |          |
| <b>Module 5</b><br><b>Species Distribution Modelling for climate change impacts:</b><br>The concept of Niche, Grinnel, Elton and Hutchinson: Fundamental and Realized. Biodiversity –Ecosystem functioning.<br>Ecosystem Services. Predicting Ecosystem consequences of biodiversity loss. Practical using software MaxENT/ InVEST including presentation by students.<br>Forest Carbon Sequestration and Blue Carbon   | 4<br><br><br><br><br><br><br><br><br>1 |           | 8        |
| <b>TOTAL</b>  | <b>27</b>                              | <b>12</b> | <b>8</b> |

**Evaluation criteria**

Test 1 : 15%

Test 2 : 15%

Tests 1 and 2 shall evaluate the students understating of the concepts, the thoroughness in readings on the topics.

Assignment and presentation : 30%

The Assignment will be on a topic assigned by the course coordinator. Assignment to include identification of a climate change ecosystem problem, literature review, designing a

methodology and a implementation plan to address the same

Major Test : : 40%

Major Test to undertake an evaluation of students comprehension of all the modules , assess the deeper understanding the student has gained through the course in the entire semester.

**Learning outcomes shall be the following:**

- 1.The students will be able to appreciate the inter-disciplinarity that is required for Studies related to impacts of climate change on different ecosystems and species.
- 2 Students will learn tools and techniques related to climate change studies and its impacts on ecosystems and the present level of global and national initiatives to address the same.
3. Students will develop an understanding on India preparedness to address impacts of climate change to ecosystems.

**Pedagogical approach:**

Students will be guided through the basic concepts of ecosystem and its linkages to climate change. It will be emphasized upon that ecosystems have been shaped by climate in a geological time period. Students will learn that resilience and vulnerability of ecosystems and species they harbour varies to climate change varies. They would learn the emergent tools and techniques to study change in distributional ranges of species through Ecological Niche Modelling. Students will be apprised of the global initiatives by conservation agencies.

**Readings**

Bannerjee, A. (2010) (Ed). Footprints in the Forest. History and Origins of Forests, Forestry and Wildlife in India. Natraj Publishers. Dehradun. P 326.

Box, E. O. 1981. Macro climate and plant forms: An introduction to predictive modelling in phytogeography. Dr. W Junk Publishers. The Hague. 258

Canadell Josep , Diane E. Pataki. 2007. (Eds). Terrestrial Ecosystems in a changing World. Springer-Verlag. Berlin. 336 P.

Edwards, Paul, N. 2010. A vast Machine. Computer models, climate data and the politics of global warming. The MIT Press. Cambridge. London. P 518.

Jones, Hamlyn. G. 2014. Plants and microclimate. Cambridge. UK. P. 407.

Lovejoy Thomas and Lee Hannah. Climate Change and Biodiversity

**Sala Osvaldo E, Robert B Jackson, Harold A Money, Robert W Howarth (Ed).2000. Methods in Ecosystem Science. Springer.420**

**Solomon Allen M and Herman S. Shugart. 1993. Vegetation Dynamics and Global Change. Springer and IIASA.P 337.**

**In addition**

Books authored by James Lovelock on Gaia hypothesis.

**Journal papers:**

Publications by Profs Raman Sukumar and N H Ravindranath at IISc Bangalore and publications from IITM, Pune.

Diamond Jared on Assembly rules

**Additional information/ Requirements (if any):** Readings may be updated for this course.

**Student responsibilities:** Attendance, Intensive readings, Active participation in Class discussions.

**Evaluated by:**

- 1.Prof P.K. Joshi, School of Environmental Sciences, Jawaharlal Nehru University
- 2.International Union for Conservation of Nature, India.
- 3.Dr Anurag Danda, Sunderbans Programme, WWF India
- 4.Dr. Indu Murthy. Consultant Scientist at Indian Institute of Science, Bangalore
- 5.Prof J Garg, GGS Indraprastha University, New Delhi.

|   |  |  |                       |                           |
|---|--|--|-----------------------|---------------------------|
| <b>Course title:</b> Climate Change and Disaster Risk Reduction   |  |  |                       |                           |
| <b>Course code:</b> NRC 162   |  | <b>No. of credits:</b> 3                           | <b>L-T-P:</b> 30-12-0 | <b>Learning hours:</b> 42 |
| <b>Pre-requisite course code and title (if any):</b>  |  |  |                       |                           |
| <b>Department:</b> Department of Energy and Environment   |  |  |                       |                           |
| <b>Course coordinator:</b>  |  | <b>Course instructor:</b> Dr Anil Kumar Gupta      |                       |                           |
| <b>Contact details:</b>   |  |  |                       |                           |
| <b>Course type:</b> Elective  |  | <b>Course offered in:</b> 3 <sup>rd</sup> semester |                       |                           |
| <b>Course Description</b><br>Climate change is known to increase disaster intensities and frequency by aggravating hazards and the factors determining vulnerability of environment, inhabiting communities and their resources. There has been a paradigm shift in approach to disaster management from response and relief centric to risk management centric, and thus, calling integration of climate change adaptation and sustainability concerns along DRR into developmental process. This course introduces the concepts, tools, methods for disaster risk management, specifically for climate and weather-related disasters; role of policies and frameworks at international, national and sub-national contexts, with focus on emerging issues and recent developments. Students are expected to attend the class after going through the reference reading materials, and participate in the guided exercises (tutorials) and undertake assignments in order to enable relevant knowledge base on the subject |  |  |                       |                           |
| <b>Course objectives</b>  |  |  |                       |                           |
| <ul style="list-style-type: none"> <li>▪ To provide a systematic knowledge base on disaster typology, risk, vulnerability, their impacts and concerns to growing hydro-met disasters,</li> <li>▪ To comprehend on approaches and measures of disaster management, preparedness and response, and related policies, law and methods,</li> <li>▪ To enumerate on possible pathways, tools and options for CCA-DRR and sustainability mainstreaming through developmental planning at sectors, department or local levels, and activities</li> </ul>   |  |  |                       |                           |
| <b>Course Contents</b>  |  |  |                       |                           |
| <b>Module</b>   | <b>Topic</b>   | <b>L</b>   | <b>T</b>              | <b>P</b>                  |
| 1.  | <b>Introduction to fundamentals of DRR</b><br>Environment-development and disasters; Disaster typology and classification; Basic concepts and terminologies – Hazard, Risk, Vulnerability, Disaster, Mitigation, DRR and its evolution, DRM, Emergency, Response, Relief; Resilience, Reconstruction, Recovery; Hydro-meteorological and related disasters; Disaster vulnerability of the region/country.  | 4  |                       |                           |
| 2.  | <b>Climate Variability &amp; Disaster Risk</b><br>Climate change, climate variability and implications on disaster risk; Climatic extreme events and disasters–global, regional and national scenario, predictions and projections. Climate change effects on disaster vulnerabilities–environmental & land/geography, social-economic, health, infrastructure, systems, etc; Recent hydro-met disasters. Climate change issues for human security, national security, trans-boundary disasters and conflicts. | 6  | 2                     |                           |
| 3.  | <b>Disaster Risk Mitigation</b><br>Disaster management journey and paradigm shift; Approaches in disaster management–Engineering centric, CBDP, Indent management, ecoDRR, etc. Structural and non-structural measures of mitigation–for hydro-met disasters, extremes and health risks –. International and national policy frameworks and guidelines.  | 4  |                       |                           |
| 4.  | <b>Disaster Risk Management</b><br>Tools and Methods in Disaster Risk Management: Hazard, risk   | 4  | 4                     |                           |

|  |   |           |           |          |
|--|---|-----------|-----------|----------|
|  | and vulnerability analysis; Legislations, Codes & Standards, Risk sensitive land use planning, Safety auditing, Role of EIA/SEA, REA of Disasters, Situation analysis, Incident response system, PDNA, Environmental economics & DRR, Recovery framework. DM Planning for Government at national/sub-national, ministry/departments, organization/establishments and at local levels.   |           |           |          |
| 5.   | <b>Disaster Preparedness</b><br>Crisis management, Early warning and communication, Emergency response, Local preparedness, Relief management– Shelter, WATSAN, environmental health, trauma care; Role of agencies, technology and coordination; Issues of green relief, sustainable recovery, built back better; CCA-DRR and sustainability integration into post-disaster/post-conflict development, International response. | 4         | 2         |          |
| 6.   | <b>Challenges and issues</b><br>Issues in Urban, Rural and Industrial disaster risks management w.r.t. climate change. Resilient agriculture, Disaster Resilient - Infrastructure, Industry, Livelihoods, Schools, Hospitals, etc. Issues of special needs – gender, aged, children, disabled, psycho-social, etc.  | 4         | 4         |          |
| 7.   | <b>Mainstreaming CCA-DRR</b><br>Role and need of CCA-DRR integration; Options, pathways and mechanisms; evolution of Yokohama, HFA, SFDRR, Integrated implementation. NRM-DRM integration, ecosystem-based adaptation and eco DRR; Role of Green growth, REDD++ and sustainable NRM – IWRM, Watershed, River basin, ICZM, Socio-economic resilience, Capacity building, etc.  | 4         |           |          |
|  | <b>Total</b>  | <b>30</b> | <b>12</b> | <b>0</b> |
| <b>Evaluation procedure</b>  |   |           |           |          |
| <ul style="list-style-type: none"> <li>▪ 2 Assignments : 40%<br/>(one assignment will be on the issues and challenges of DRR, will be given after the completion of the two modules; Second will be given in the middle of the semester that will assess the understanding of the students on various topics covered so far and linkages with first assignment)</li> <li>▪ Tests 1 : 15%</li> <li>▪ Tests 2 : 15%</li> <li>▪ Test 3 : 30%</li> </ul>   |   |           |           |          |
| <b>Learning outcomes</b>   |   |           |           |          |
| <ul style="list-style-type: none"> <li>▪ To develop a sound understanding of disaster risk and related underlying factors, their impacts, (Assignment 1 and test 1)</li> <li>▪ To appreciate and comprehend on approaches and measures of disaster management, preparedness and response, and related policies, law and methods (test 2)</li> <li>▪ To know various pathways, tools and entry points for integrating CCA-DRR and sustainability concerns into developmental planning across sectors, national, sub-national and local plans and actions of DM (Assignment 2 and test 3)</li> </ul> |   |           |           |          |
| <b>Pedagogical approach</b>  |   |           |           |          |
| Classroom teaching will involve power point presentations, case study analysis and assignment-based seminar.   |   |           |           |          |
| <b>Suggested Readings</b>  |   |           |           |          |
| <ul style="list-style-type: none"> <li>• Rajib Shaw and R.R. Krishnamurthy (2009). Disaster Management: Global Challenges and Local Solutions. Universities Press (India) Pvt. Ltd.</li> <li>• Ross Prizzia (2015). Climate Change and Disaster Management. Sentia Publishing, USA.</li> </ul>   |   |           |           |          |



- Anil K Gupta, S S Nair, S Chatterji and Florian B-Lux (2013). Disaster Management and Risk Reduction. Narosa Publishing New Delhi.
- Anil K Gupta, S S Nair and V K Sharma (2018). Disaster Risk and Impact Management, Astral Publishing, New Delhi.
- Anil K Gupta, Jane Eppers and Ilona Porche (2011). Adaptation in Disaster Risk Management. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and Govt of India MoEFCC.
- Anil K Gupta, S Singh, S A Wajih (2017). Urban Resilience and Sustainability Through Peri-urban Ecosystem. Rockefeller Foundation, USA and GEAG India.
- Anil K Gupta, S Singh, S Katyal and S A Wajih (2016). Prime Minister's Agenda 10: India's Disaster Risk Management: Roadmap to Climate Resilient and Sustainable Development. CDKN – UK, ISET USA and GEAG India.
- Anil K Gupta, S Singh, S Katyal and S A Wajih (2016). Climate Resilient and Disaster Safe Development: Process Framework. CDKN UK, ISET USA.
- Anil K Gupta, S S Nair (2014). Mainstreaming Climate Change Adaptation and Disaster Risk Reduction into District Level Development Plans. CDKN UK, ISET USA and NIDM India.
- Anil K Gupta, S S Nair (2013). Environmental Legislation for Disaster Risk Management. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and NIDM India.
- Anil K Gupta, S S Nair (2012). Environmental Extremes - Disaster Risk Management: Addressing Climate Change. NIDM New Delhi, India.
- <http://drought.unl.edu/Portals/0/docs/international/India%20Drought%20Manual%202016.pdf>

#### Case studies

Uttarakhand Disaster 2013, Cyclone Phailin 2014, Kashmir Flood 2015, Drought 2015, Forest Fire 2015

Heat wave 2015-16, Cyclone Hudhud, Bundelkhand drought, etc.

IPCC-SREX Case Studies [https://www.ipcc.ch/pdf/special-reports/srex/SREX-Chap9\\_FINAL.pdf](https://www.ipcc.ch/pdf/special-reports/srex/SREX-Chap9_FINAL.pdf)

EcoDRR <https://www.preventionweb.net/publications/view/26498>

#### Websites

UN-ISDR <https://www.unisdr.org/>

PEDRR <http://pedrr.org/>

IUCN CEM <https://www.iucn.org/commissions/commission-ecosystem-management/regions/south-asia>

CDKN [https://cdkn.org/themes/theme-disaster-risk-management/?loclang=en\\_gb](https://cdkn.org/themes/theme-disaster-risk-management/?loclang=en_gb)

WMO <http://www.wmo.int/pages/prog/drr/>

NIDM <http://nidm.gov.in/default.asp>

NDMA <http://www.ndma.gov.in/en/>

<https://www.beforetheflood.com/>

Researchgate [https://www.researchgate.net/profile/Anil\\_Gupta15](https://www.researchgate.net/profile/Anil_Gupta15)

#### Journals

Disaster Resilience in Built Environment (Emerald)

International Journal of Disaster Risk Reduction (Elsevier)

Journal of Geography and Natural Disasters (Omics)

International Journal of Disaster Risk Science (Springer)

Disaster and Development Journal (NIDM)

#### Additional information (if any)

#### Student responsibilities

The students are expected to submit assignments in time and come prepared with readings when provided.

#### Course Reviewers

The course is reviewed by the following experts.

1. Prof. V K Sharma, Vice Chairman, Sikkim State Disaster Management Authority, IIPA, New Delhi.
2. Prof. Rajib Shaw (UNISDR S&T Council Convenor), Keio University, Japan.

| <b>Course title:</b> Advance Climate Modelling  |  |  |                        |                           |
|---|--|--|------------------------|---------------------------|
| <b>Course code:</b> NRC172  |  | <b>No. of credits:</b> 3                       | <b>L-T-P:</b> 24-12-12 | <b>Learning hours:</b> 42 |
| <b>Pre-requisite course code and title (if any):</b> Introduction to Climate Modelling (Sem 2)  |  |  |                        |                           |
| <b>Department:</b> Department of Energy and Environment   |  |  |                        |                           |
| <b>Course coordinator:</b>  |  | <b>Course instructor:</b> Mr. Saurabh Bhardwaj |                        |                           |
| <b>Contact details:</b> saurabh.bhardwaj@teri.res.in  |  |  |                        |                           |
| <b>Course type:</b> Elective  |  | <b>Course offered in:</b> Semester 3           |                        |                           |
| <b>Course Description</b>   |  |  |                        |                           |
| On completion of this course, students should be able to understand fundamental principles of climate modelling architecture, their physics and dynamics, their bias methodology and their practical usability. The course explains how climate models work and operate under various uncertainty and constraints. The course would also have hands on activity on using the models and generating and analyzing climate data for further usage |  |  |                        |                           |
| <b>Course objectives</b>  |  |  |                        |                           |
| <ul style="list-style-type: none"> <li>• Introduce students to the practical usability of climate models</li> <li>• Understand the structure and usage of various data products in climate sciences</li> <li>• Become mindful of the necessary technical know-how of running, testing and evaluation a climate model dataset.</li> </ul>  |  |  |                        |                           |
| <b>Course Contents</b>  |  |  |                        |                           |
| Module  | Topic  | L  | T                      | P                         |
| 1.  | Basics of Global Climate and climate variability<br>Climate sciences (Radiative forcing, energy budget, ENSO, IOD etc.)-<br>a) Atmospheric flows and forces<br>b) Modelling architecture<br>c) Modelling basics, equations, types and usability  | 4  |                        |                           |
| 2.  | Atmospheric Dynamics concepts -<br>a) Flow balances, thermal wind, circulation and vorticity<br>b) Circulation theorem<br>c) Kinematics of pressure systems  | 4  | 4                      |                           |
| 3.  | Building blocks of a climate system model –<br>a) Model Components<br>b) Resolved processes (dynamical and kinematics)<br>c) Numerical representation of atmospheric and oceanic equations (boundary, initial conditions, parameterizations)<br>d) Atmospheric model, Land model, Ice model  | 6  | 4                      |                           |
| 4.  | Testing of Models –<br>a) Model Bias<br>b) SST, Sea Ice, precipitation, model and natural variability<br>c) Uncertainty and sensitivity<br>d) Model skill  | 6  |                        | 2                         |
| 5.  | Hands On -<br>a) Model porting and running on Linux machines (WRF, PRECIS etc)<br>b) Different grid systems and data formats<br>c) Open source climate datasets and their types<br>d) Climate data generation via modelling tools<br>e) Concept of validation<br>f) Climate data analysis via CDO<br>g) Trend plotting, bias, error estimation | 4  | 4                      | 10                        |

| <b>Total</b>  | <b>24</b> | <b>12</b> | <b>12</b> |
|---|-----------|-----------|-----------|
| <b>Evaluation procedure:</b><br>Test 1: 20%<br>Test 2: 20%<br>Assignments (including tutorials): 20%; this will be given after Test 2 to assess the tool-based understanding<br>Test 3: 40%   |           |           |           |
| <b>Learning outcomes:</b> <ul style="list-style-type: none"> <li>• Ability to distinguish between different climate data operators (test 1)</li> <li>• Ability to port and run a simple model (test 2 and tutorials)</li> <li>• Developed understanding of dynamical processes in a model (assignment and tutorials)</li> <li>• Application of modelling outputs towards extreme climate analysis (test 3)</li> </ul>   |           |           |           |
| <b>Pedagogical approach</b><br>Class room teaching with hands-on exercises on climate data analysis   |           |           |           |
| <b>Materials</b><br><br><b>List of practicals:</b> <ol style="list-style-type: none"> <li>1. Model porting techniques</li> <li>2. To understand different grid systems and data formats</li> <li>3. Working knowledge of open source climate datasets and their types</li> <li>4. Generation of Climate data via modelling tools</li> <li>5. Concept of validation</li> <li>6. Climate data analysis using CDO</li> <li>7. Trend plotting, bias, error estimation in climate datasets</li> </ol><br><b>Required text</b> <ul style="list-style-type: none"> <li>• Gettelman A. and Rood R.B., Demystefying Climate Models.</li> <li>• Goosse H., Barriat P.Y., Lefebvre W., Loutre M.F. and Zunz V., Introduction to Climate Dynamics and Climate Modeling.</li> <li>• James R.H. An Introduction to Dynamic Meteorology, International Geophysics Series</li> <li>• Steven A. Ackerman and John A. Knox, Meteorology Understanding the Atmosphere</li> <li>• Thomas T Warner, Numerical Weather and Climate Prediction</li> </ul><br><b>Suggested readings</b> <ul style="list-style-type: none"> <li>• Jacobson M.Z. Fundamentals of Atmospheric Modeling.</li> <li>• McGuffie K. (Henderson-Sellers A., A Climate Modelling Primer, John Wiley &amp; Sons.</li> <li>• Washington W.M. and Parkinson C.L, Introduction to Three-dimensional Climate Modeling</li> </ul><br><b>Websites</b> <ul style="list-style-type: none"> <li>• <a href="http://www.m2lab.org">www.m2lab.org</a></li> </ul><br><b>Journals</b> <ul style="list-style-type: none"> <li>• Geophysical Research</li> <li>• Global Environmental Change</li> <li>• Climate Dynamics</li> <li>• Current Science</li> </ul> |           |           |           |
| <b>Additional information (if any)</b><br>Regular tutorial and assignments will be given  |           |           |           |
| <b>Student responsibilities</b><br>Attendance, timely feedback, discipline: as per university rules, adopt peer learning and knowledge sharing within the class.  |           |           |           |

### Course Reviewers:

The course is reviewed by the following experts.

1. Dr. Akhilesh Mishra, Associate Faculty (Courtesy Appointment) COAPS, The Florida State University, Tallahassee, FL, USA and Associate Professor and Coordinator, Interdisciplinary Center for Climate Research and Policy, Amity University, Jaipur, Rajasthan.
2. Dr. Madhusoodanan M.S., Associate Professor, Amrita Vishwa Vidyapeetham, Amritanagar, Coimbatore - 641 112, Tamil Nadu.

|   |   |                          |                     |          |
|---|---|--------------------------|---------------------|----------|
| <b>Course title:</b> Economics of Climate Change  |   |                          |                     |          |
| <b>Course code:</b> NRC-145   |   | <b>No. of credits:</b> 3 | <b>L-T-P-34-8-0</b> |          |
| <b>Course Prerequisites:</b> Familiarity with the mathematics at CBSE/ISC +2 Level  |   |                          |                     |          |
| <p><b>Course Description:</b> The course encompasses the fundamentals in economics of climate change. The focus is on the fact that many issues related to climate change problem environmental resources fall outside the purview of the market mechanisms. The course also aims to develop an understanding of the economic framework of decision-making in which policy issues related to climate change issues are currently being debated at various forums.</p> <p>The specific issues that students would be discussing in the course are as follows: How Economic System Affects and gets Affected by Climate Change? What policy instruments and institutional arrangements can we avail of–nationally and internationally–to bring about actions necessary to prevent atmospheric concentration of GHG emissions from reaching ‘dangerous levels’? What political and economic considerations are influencing the course of international negotiations?</p> |   |                          |                     |          |
| <p><b>Course objective:</b> The aim of the course is:</p> <ul style="list-style-type: none"> <li>• To introduce the students to economic analysis of climate change</li> <li>• To examine the economic instruments at global, regional and local levels for making policy choices related to climate change</li> <li>• To analyze the economic principles in work at Institutional Mechanisms devised to deal with climate change problems.</li> </ul>  |   |                          |                     |          |
| <b>Course content</b>   |   |                          |                     |          |
| <b>Module</b>   | <b>Topic</b>  | <b>L</b>                 | <b>T</b>            | <b>P</b> |
| 1   | <b>Analysing the Cause and Effect Relationship between Economic System and Climate Change</b><br>Atmospheric commons; Stock and Flows of emissions; GHG emissions as externalities; Impacts of climate change over time and space; Uncertainty and Irreversibility  | 6                        | 0                   | 0        |
| 2   | <b>Methods of Valuation of Ecosystem Services with Special Emphasis on Climate Change</b><br>Market and non-market benefits, user benefits, non-user benefits and option value benefits<br>Methods of valuation: physical linkage methods; hypothetical behavioural and stated preferences methods; observed behavioural or revealed preferences methods, Discounting | 8                        | 4                   | 0        |
| 3   | <b>Economic Policy Instruments in Addressing Climate Change</b><br>Direct regulation; emission taxes and abatement subsidies; tradable permits: choice of instrument (trading vs. taxation, price vs. quantities, fiscal impacts, distributional considerations)  | 8                        | 4                   | 0        |
| 4   | <b>Institutions for Addressing Climate Change by Application of Economic Principles</b><br>Kyoto Protocol and its Mechanisms (CDM, JI): Trans-border Carbon Adjustments, REDD++, International Climate Change Agreements  | 12                       | 0                   | 0        |
|   |   | <b>34</b>                | <b>8</b>            | <b>0</b> |
| <b>Evaluation criteria</b>  |   |                          |                     |          |
| <ol style="list-style-type: none"> <li>1. Test 1- Term Paper (10% for presentation and 10% for report)- 20%</li> <li>2. Test 2 – Take Home Graded Assignments (3 in number) – 30%</li> <li>3. Test 3 - End Semester Major Exam – 50%</li> </ol>   |   |                          |                     |          |
| <b>Learning outcomes:</b> After pursuing the course, the student will be able to:   |   |                          |                     |          |

- Understand the nuances behind the working of successful environmental and climate change policies and not so successful ones. (test 1 and test 2)

Appreciate the working of economic principles in terms of incentives behind any decision taken by different economic agents that affect the environment and climate change, (test 3)

### **Pedagogical approach**

Classroom teaching will involve black board, discussion of examples, building up on basic concepts.

### **Reading Materials**

#### **Textbooks**

Barrett S. (2003) *Environment and Statecraft*, New York, Oxford University Press.

Bruce J., Lee H. and Haites E., (1995): *Climate Change: Economic and Social Dimensions of Climate Change*. Cambridge, Cambridge University Press.

Gaskins D. and Weyant J., (1993): *Reducing Global Carbon Dioxide Emissions: Costs and Policy Options*, Energy Modeling Forum, Stanford University

Griffin J., (2003): *Global Climate Change: The Science, Economics and Politics*.

Cheltenham: Edward Elgar.

Kolstad C.D. (2002) *Environmental Economics*, Oxford University Press.

Nick H., Jason F.S. and Ben W. (1997) *Environmental Economics—In theory and Practice*, Macmillan Publishers India.

Nordhaus W. (1994) *Managing the Global Commons*, Cambridge, MA, MIT Press.

### **Student responsibilities**

The nature of the course demands that the students shall attend all lectures. Discipline and attendance must be maintained in class.

### **Course reviewers**

1. Dr. Sarthak Gaurav, Assistant Professor, SJMSOM, IIT Mumbai
2. Dr. Upasak Das, Post-Doctoral Fellow, University of Pennsylvania

| <b>Course title:</b> Renewable Energy Technologies   |   |  |                           |   |
|--|---|--|---------------------------|---|
| <b>Course code:</b> ENR XXX  | <b>No. of credits:</b> 4  | <b>L-T-P:</b> 38-4-0   | <b>Learning hours:</b> 42 |   |
| <b>Pre-requisite course code and title (if any):</b> NRC 183   |   |  |                           |   |
| <b>Department:</b> Department of Energy and Environment  |   |  |                           |   |
| <b>Course coordinator:</b> Dr. Naqui Anwer   |   | <b>Course instructor:</b> Dr. Som Mondal, Dr. Jami Hossain, Dr. Priyanka Kaushal, Dr. Atul Kumar |                           |   |
| <b>Contact details:</b> naqui.anwer@terisasa.ac.in   |   |  |                           |   |
| <b>Course type:</b> Elective   |   | <b>Course offered in:</b> Semester 3   |                           |   |
| <p><b>Course description:</b><br/>The course is designed to make the students conversant with the renewable energy technologies. The course focuses on constructional details, working principles and operation of different RE technologies for power generation and beyond. It provides an opportunity to the students to get widespread knowledge and train with the tools and techniques used in RE industry.</p> <p><b>Course objectives</b></p> <p>The objective of the courses is to develop in-depth knowledge for the following:</p> <ol style="list-style-type: none"> <li>1. Construction and operation of different solar PV technologies and their applications</li> <li>2. Solar PV business models</li> <li>3. Construction and operation of different solar thermal technologies and their applications</li> <li>4. Construction and operation of different Wind Energy Conversion Systems (WECS) and their applications</li> <li>5. Construction and operation of different biomass and biogas technologies and their applications</li> <li>6. Introduction to Geothermal, wave energy, tidal energy, ocean thermal energy technologies for power generation</li> </ol> |   |  |                           |   |
| <b>Course contents</b>   |   |  |                           |   |
| Module   | Topic   | L  | T                         | P |
| <b>SOLAR</b>   |   |  |                           |   |
| 1  | <b>Solar Photovoltaic Technologies</b><br>Solar PV systems, Balance of System (BoS) components: battery, PCU (charge controller, inverter, data logger), transformer, cables and connectors, switches/circuit breakers, energy meters, bypass and blocking diodes<br>Types of PV systems: Standalone, grid-connected, hybrid, Rooftop business models – CAPEX and RESCO | 8  | 2                         | 0 |
| 2  | <b>Solar PV applications</b><br>Lighting, agriculture, refrigeration, telecommunications, space, BIPV, fencing, water purification, navigation, defence, offshore, etc.   | 2  | 0                         | 0 |
| 3  | <b>Solar Thermal Collectors</b><br>Flat plate collectors: general design features and characteristics, materials.   | 6  | 2                         | 0 |



|   |  |           |          |          |
|---|--|-----------|----------|----------|
|   | <p>Unglazed, Single and double glazed solar collectors, Optical losses and thermal losses</p> <p>Evacuated tube collectors: general design features, characteristics, materials,</p> <p>Concentrating solar collectors: General description; concentrators, receivers, Orienting/tracking requirements, Materials</p> <p>parabolic trough collectors (PTC), Paraboloid dish collectors, Scheffler dish, Linear Fresnel Reflector Collector</p> |           |          |          |
| <b>4</b>  | <p><b>Solar Thermal Applications</b></p> <p>Solar hot water systems, Solar cookers: box type, dish type and others; dryers; desalination systems; absorption cooling; furnace, Process heating systems, community cooking system; power generation</p>   | 4         | 0        | 0        |
| <b>WIND</b>   |  |           |          |          |
| <b>5</b>  | <p><b>Wind power generation technologies</b></p> <p>Basic concept of Wind Energy Conversion System (WECS), classification/types of wind turbines, different types of generators used in wind power generation and their applications.</p>  | 6         | 0        | 0        |
| <b>BIOMASS</b>  |  |           |          |          |
| <b>6</b>  | <p><b>Biomass Technologies</b></p> <p>Aerobic and anaerobic processes, activated sludge process, plug flow reactors, anaerobic fixed film reactor, UASB reactor, anaerobic fluidized bed reactor, anaerobic digestion system for MSW, Vermi-composting, different designs of biogas plants for animal waste, Biogas engine applications</p>  | 8         | 0        | 0        |
| <b>SMALL HYDRO</b>  |  |           |          |          |
| <b>7</b>  | <p><b>Small hydro technologies</b></p> <p>Difference between large and small hydro technologies, construction and operation of small hydro power plant, special requirements.</p>  | 2         | 0        | 0        |
| <b>GEOHERMAL AND OCEAN ENERGY</b>   |  |           |          |          |
| <b>8</b>  | <p>Geothermal, wave energy, tidal energy, ocean thermal energy technologies for power generation.</p>  | 2         | 0        | 0        |
|   | <b>Total</b>   | <b>38</b> | <b>4</b> | <b>0</b> |
| <p><b>Evaluation criteria:</b></p> <p>Test 1: Assignments (after the end of each section) - 30%</p> <p>Test 2: Written test (after completion of modules 1, 2, 3 and 4) - 30%</p> <p>Test 3: Written test (after completion of modules 5, 6, 7 and 8) - 40%</p> |  |           |          |          |

**Learning outcomes:**

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

1. Identify appropriate RE technology for power generation (Test 2 and 3)
2. Design and develop the power generation fixtures based on RE technologies (Test 2 and 3)
3. Provide performance evaluation for RE plants (Test 1, 2 and 3)

**Pedagogical approach:**

A combination of class-room interactions, group discussion and presentations, tutorials and assignments

**Materials:****Text Books:**

1. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. VVN Kishore (TERI Press, 2008).
2. CS Solanki: Solar Photovoltaics – Fundamentals, Technologies and Applications, Third Ed (PHI Learning, 2015)
3. Paul Breeze, “Wind power generation”, Academic Press (Elsevier), First edition, 2015

**Reference Books:**

1. Handbook of photovoltaic science and engineering, ed. Antonio Luque and Steven Hegedus (John Wiley and Sons, 2011)
2. JA Duffie and WA Beckman, “Solar Engineering of Thermal Processes”, Third Edition (John Wiley & Sons)
3. S Sukhatme and J Nayak, “Solar Energy: Principles of Thermal Collection and Storage”, Third Edition (Tata McGraw Hill, 2008)
4. TERI Energy Data Directory (TEDDY) 2016 (TERI Press, 2016)
5. Paul Gipe, “Wind energy basics: A guide to small and micro wind”, Chelsea Green Publishing, 2008)
6. Adam Harvey, Andy Brown and Priyantha Hettiarachi: Micro-Hydro Design Manual: A Guide to Small-scale water power schemes (ITDC Publishing, 1993)
7. Donald Klass, “Biomass for Renewable Energy, Fuels, and Chemicals”, (Entech International Inc., USA) Godfrey Boyle, “Renewable Energy”, (Atlantic Publishing Company, 2008)

**Websites:**

1. Ministry of power
2. Ministry of new and renewable energy
3. Planning commission

**Additional information (if any):**

There will be test before and after the completion of the course

**Student responsibilities:**

Attendance, timely feedback, discipline: as per university rules, adopt peer learning and knowledge sharing within the class

**Course reviewers (Tentative):**

1. Dr. Ashu Verma, Assistant Professor, IIT Delhi
2. Dr. Apel Mahmud, Associate Professor, Deikin University, Australia

| Course title: Energy Systems Modelling  |  |   |                 |                    |
|---|--|---|-----------------|--------------------|
| Course code: NRC xxx  |  | No. of credits: 3                       | L-T-P: 32-10-00 | Learning hours: 42 |
| Pre-requisite course code and title (if any): NA  |  |   |                 |                    |
| Department: Department of Energy and Environment  |  |   |                 |                    |
| Course coordinator: Professor Atul Kumar  |  | Course instructor: Professor Atul Kumar |                 |                    |
| Contact details: atul.kumar@terisas.ac.in   |  |   |                 |                    |
| Course type: Elective   |  | Course offered in: Semester 3           |                 |                    |
| <b>Course description:</b><br><p>As a part of the course, the students will be acquainted with the framework for energy modelling and analysis, including a detailed overview of various modelling approaches deployed for policy research and analysis for facilitating decisions makers in energy planning and policy formulation. An understanding of the fundamentals of the energy systems modelling allows students to develop skills for critically evaluating the modelling approach to be deployed for the problem/research question at hand. Students will also be trained in methods for deriving the appropriate input drivers used in energy system modelling.</p> |  |   |                 |                    |
| <b>Course objectives:</b> <ul style="list-style-type: none"> <li>To introduce students to the basics of energy modelling including terminology, methods, tools and techniques of energy modelling available to energy practitioners for understanding, assessing and analysing energy systems;</li> <li>To impart knowledge on financial analysis of energy technologies</li> <li>To successfully equip students on application of modelling techniques for energy-economy-environment interaction related policy analysis and research</li> </ul>  |  |   |                 |                    |
| Module no.  | Topic  | L                                       | T               | P                  |
| 1   | <b>Introduction:</b><br>Introduction to modelling and decision analysis; rationale for energy systems modelling; classification of energy models: top-down, bottom up and hybrid models.   | 2                                       | 0               |                    |
| 2   | <b>Background tools:</b><br>Time value of money; simple and discounted payback period; net present values; internal rate of return; benefit to cost ratio; levelized costs; variable and fixed costs; case studies on techno-economic evaluation of renewable energy technologies.   | 8                                       | 3               |                    |
| 3   | <b>Energy database</b><br>Energy data: basic features of energy data; energy data base development; data identification; energy data collection; data analysis   | 2                                       | 0               |                    |
| 4   | <b>Energy demand and supply analysis:</b><br>Energy demand driver analysis; Sectoral disaggregation of energy;<br>Energy demand projections: Methodologies <ul style="list-style-type: none"> <li>- Trend analysis;</li> <li>- End-use method;</li> <li>- Econometric approach</li> </ul> Energy supply perspective; Energy supply systems; Resource assessment. | 8                                       | 3               |                    |
| 5   | <b>Energy modelling</b><br>Reference Energy System (RES); integrated energy planning; introduction to multi criteria decision analysis; fundamentals of the TIMES energy model; case study on co-benefits of climate change mitigation options such as health benefits due to improved air quality from replacement of fossil fuel by renewables.                | 8                                       | 4               |                    |

|   |   |    |    |   |
|---|---|----|----|---|
| <b>6</b>  | <b>Translation of model output into policy</b><br>Perspective of policy analysis; policy responses: reduce, replace, and restrict; energy governance and policies: Electricity Act (EA), National Electricity Policy (NEP), Feed-in-Tariffs, Renewable Portfolio Standards; evaluation of alternatives; scenario analysis | 6  | 0  |   |
|   | <b>Total</b>  | 32 | 10 | 0 |
| <b>Evaluation criteria:</b>   |   |    |    |   |
| <ul style="list-style-type: none"> <li>• Test 1: 15%</li> <li>• Test 2: 15%</li> <li>• Test 3: 50%</li> <li>• Assignment/Tutorials: 20%</li> </ul> <p>(Assignment one will be given after the completion of 3 modules, students need to submit case studies in this linking to the teaching covered; tutorials will have based on module 4 and 5, tool-based understanding will be assessed)</p>  |   |    |    |   |
| <b>Learning outcomes:</b>   |   |    |    |   |
| <p>After completing this course students will be able to</p> <ul style="list-style-type: none"> <li>▪ Evaluate options for energy supply, distribution and utilisation (Test 1)</li> <li>▪ Understand the role of long term energy-economic- environment modelling in the planning process (Test 1)</li> <li>▪ Understand important outputs of bottom-up energy-economic- environment modelling outputs in terms of their economic implications (Test 2 and Assignment 1)</li> <li>▪ Define and understand linkages between energy and climate change from an energy planning perspective (Test 2, Test 3 and tutorials)</li> <li>▪ Understand and evaluate different scenarios of energy demand and supply with implications on energy policy thereof. (Test 3)</li> </ul> |   |    |    |   |
| <b>Pedagogical approach:</b>  |   |    |    |   |
| <p>The course will be delivered through classroom lectures. Relevant case studies shall be discussed in class so that students are introduced to the latest stage of development on the subject.</p>  |   |    |    |   |
| <b>Materials:</b>   |   |    |    |   |
| <b>Textbooks</b>  |   |    |    |   |
| Bhattacharyya, S C. (2011), Energy Economics: Concepts, Issues, Markets and Governance, Springer  |   |    |    |   |
| Kandpal T.C. & Garg, H.P. (2003), Financial Evaluation of Renewable Energy Technologies, Macmillan India  |   |    |    |   |
| Kornelis Block, 2009. Introduction to Energy Analysis, Techne Press   |   |    |    |   |
| Munasinghe, M., & Meier, P. (1993). Energy policy analysis and modelling. Cambridge University Press.   |   |    |    |   |
| <b>Suggested readings</b>   |   |    |    |   |
| Giannakidis, G., Labriet, M., O'Gallachóir, B. P., & Tosato, G. (2015). Informing energy and climate policies using energy systems models. Springer International Publishing.   |   |    |    |   |
| ETSAP, IEA. "TIMES home page." URL: <a href="https://iea-etsap.org/index.php/etsap-tools/model-generators/times">https://iea-etsap.org/index.php/etsap-tools/model-generators/times</a>   |   |    |    |   |
| Loulou, R., Goldstein, G., & Noble, K. (2004). <i>Documentation for the MARKAL Family of Models</i> , ETSAP.  |   |    |    |   |

Loulou, R., & Labriet, M. (2008). *ETSAP-TIAM: the TIMES integrated assessment model Part I: Model structure*. Computational Management Science, 5(1), 7-40.

Loulou, R., Remme, U., Kanudia, A., Lehtila, A., & Goldstein, G. (2005). *Documentation for the TIMES Model Part II*. Energy technology systems analysis programme (ETSAP).

Herbst, A., Toro, F., Reitze, F., and Jochem, E. (2012). Introduction to Energy Systems Modelling. *Swiss Journal of Economics and Statistics*, Vol. 148, No. 2, pp. 111-135.

### **Journals**

Applied Energy

Computational Management Science

Energy Policy

Energy Economics

Energy

**Additional information (if any):** NA

### **Student responsibilities:**

Attendance, feedback, discipline: as per university rules.

### **Course Reviewers**

1. Professor Jyotirmay Mathur, Centre for Energy & Environment, Malaviya National Institute of Technology Jaipur
2. Dr. Pallav Purohit, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

| Course title: <b>Energy Audit and Management</b>  |   |                   |                                 |                    |
|---|---|-------------------|---------------------------------|--------------------|
| Course code: ENR 116  |   | No. of credits: 3 | L-T-P: 30-08-08                 | Learning hours: 46 |
| Pre-requisite course code and title (if any): NA  |   |                   |                                 |                    |
| Department: Department of Energy and Environment  |   |                   |                                 |                    |
| Course coordinator: Sapan Thapar  |   |                   | Course instructor: Sapan Thapar |                    |
| Contact details: sapan.thapar@teri.res.in   |   |                   |                                 |                    |
| Course type: Elective   |   |                   | Course offered in: Semester 3   |                    |
| <b>Course description:</b><br>Energy Audit helps to map the flow of energy (in its various forms) across the value chain, highlighting areas for interventions. It shall complement the knowledge gained by students in the subject 'Energy Management'. This course is designed to sensitize students on the mechanism of energy audit and the technologies/ tools typically employed to undertake an audit exercise, supported by case studies & site visits. |   |                   |                                 |                    |
| <b>Course objectives:</b> <ul style="list-style-type: none"> <li>▪ To understand Energy Audit procedure along with relevant technologies/ tools</li> <li>▪ To understand Energy Conservation measures undertaken across different user segments using case studies</li> <li>▪ To develop Energy Audit Report writing skills</li> </ul>  |   |                   |                                 |                    |
| <b>Course contents</b>  |   |                   |                                 |                    |
| Module  | Topic   | L                 | T                               | P                  |
| 1   | <b>Energy Management &amp; Government Programmes</b><br>Introduction to Energy Management<br>Energy Conservation Act<br>BEE & State Development Agencies<br>Government & EESL Programmes<br>PAT Scheme<br>Ujala & SEEP Programmes<br>Municipal & Agriculture DSM Initiatives<br>Standards and Labelling Programme<br>EEC initiatives in Other Sectors | 4                 |                                 |                    |
| 2   | <b>Energy Audit Basics</b><br>Definition and Objectives<br>Energy Profiling<br>Energy Flow diagram<br>Types of Energy Audit<br>Duties of Energy Auditor & Manager   | 4                 |                                 |                    |
| 3   | <b>Energy Audit Procedure</b><br>Energy Audit Procedure<br>Tools/ Techniques/ Equipment<br>Energy Audit Report<br>Financing EEC Activities  | 4                 |                                 |                    |
| 5   | <b>Energy Analytics</b><br>Energy & ITES Applications   | 4                 |                                 |                    |

|  |  |    |   |   |
|--|--|----|---|---|
|  | Building Management System   |    |   |   |
| <b>6</b>   | <b>Case Studies / Best Practices</b><br>Large Industries (Cement/ Iron & Steel/ Thermal Power Plants)<br>SME Units<br>Power Distribution Utilities / Railways<br>Buildings/ Hotel/ Other Sectors | 8  | 4 |   |
| <b>7</b>   | <b>Site Visits &amp; Practical Work</b><br>Institutional Visit<br>Developing Energy Audit Report   | 6  | 4 | 8 |
|  | <b>Total</b>   | 30 | 8 | 8 |
| <b>Evaluation criteria:</b><br>Test 1: Assignments (after completion of modules 1, 2 and 3)- 20%<br>Test 2: Written test (after completion of modules 1, 2, 3 and 4)- 25%<br>Test 3: Written test (after completion of modules 5 and 6)- 25%<br>Test 4: Audit Report (after completion of modules 6 and 7) - 30%   |  |    |   |   |
| <b>Learning outcomes:</b> <ul style="list-style-type: none"> <li>▪ Identification of energy conservation opportunities in various industrial processes (Test 1)</li> <li>▪ Gain knowledge on tools and techniques employed in energy auditing (Test 2 and 3)</li> <li>▪ Comprehend an Energy Audit report, including economic parameters (Test 4)</li> </ul>   |  |    |   |   |
| <b>Pedagogical approach:</b><br>A combination of class-room interactions, tutorials, assignments, site visits, expert talks and project work   |  |    |   |   |
| <b>Materials:</b><br><b>Text Books:</b><br>LC Witte, PS Schmidt and DR Brown: <b>Industrial Energy Management and Utilization</b><br>(Hemisphere Publishing Corporation, Washington, 1998).<br><br>Reference Books:<br>JL Threlkeld: <b>Thermal Environmental Engineering</b> , Second Edition (Prentice Hall, 1970)<br>YP Abbi and Shashank Jain: <b>Handbook on Energy Audit and Environment Management</b> , (TERI Press, 2006)<br>WC Turner: <b>Energy Management Handbook</b> , Seventh Edition, (Fairmont Press Inc., 2007)<br>George Polimeros: <b>Energy Cogeneration Handbook</b> , (Industrial Press, Inc., New York, 1981)<br><br>Websites:<br>National Productivity Council ( <a href="http://www.npcindia.gov.in/">http://www.npcindia.gov.in/</a> )<br>Bureau of Energy Efficiency ( <a href="https://www.beeindia.gov.in/">https://www.beeindia.gov.in/</a> )<br>Petroleum Conservation Research Association ( <a href="http://www.pcrs.org/">http://www.pcrs.org/</a> )<br>EA/EM Guide Books ( <a href="http://www.em-ea.org/">http://www.em-ea.org/</a> ) |  |    |   |   |
| <b>Additional information (if any):</b> N.A.   |  |    |   |   |
| <b>Student responsibilities:</b><br>Attendance, feedback, discipline: as per university rules.   |  |    |   |   |

**Course reviewers:**

- 1) Mr RP Gokul, Head (Energy Efficiency Division), ICF International
- 2) Mr Amit Kumar, Sr. Director, TERI

|   |   |  |                              |          |
|---|---|--|------------------------------|----------|
| <b>Course title:</b> Energy Simulation Laboratory   |   |  |                              |          |
| <b>Course code:</b> ENR 107   | <b>No. of credits:</b> 3  | <b>L-T-P:</b> 13-0-58                        | <b>Learning hours:</b><br>71 |          |
| <b>Pre-requisite course code and title (if any):</b> NA   |   |  |                              |          |
| <b>Department:</b> Department of Energy and Environment   |   |  |                              |          |
| <b>Course coordinator:</b> Prof. Atul Kumar   |   | <b>Course instructor:</b> Respective faculty |                              |          |
| <b>Contact details:</b> atul.kumar@terisas.ac.in  |   |  |                              |          |
| <b>Course type:</b> Core  |   | <b>Course offered in:</b> Semester 3         |                              |          |
| <b>Course description</b>   |   |  |                              |          |
| <p>Energy software are widely used for policy analysis, scenario evaluation, system design and financial analysis. The availability of cheap computing power has increased both the sophistication and accessibility of these softwares, providing the planning and policy communities with an increasingly broad range of studies, as well as the ability to produce their own assessments. Such assessments offer a reasonably transparent and objective foundation for studies of critical energy-related issues, including the need to mitigate global climate change, improve air quality. Each software module covers the basic understanding of the use of the software and exercises focusing on in-depth analysis of various applications.</p> |   |  |                              |          |
| <b>Course objectives</b>  |   |  |                              |          |
| The course is designed to train students on various simulation and analysis software used for design and/or analysis of renewable energy technologies.  |   |  |                              |          |
| <b>Module</b>   | <b>Topic</b>  | <b>L</b>                                     | <b>T</b>                     | <b>P</b> |
| 1   | <b>RET Screen</b><br>(i) Design and sizing RET Projects (ii) Greenhouse Gas (GHG) Emission Reduction Analysis (ii) Financial Analysis for various case studies listed below <ol style="list-style-type: none"> <li><b>Photovoltaic Project Model</b> for on-grid (central-grid and micro-grid PV systems); off-grid (stand-alone (PV-battery) and hybrid (PV-battery-genset) systems; and water pumping applications</li> <li><b>Wind Energy Project Model</b> for central-grid and micro-grid connected projects, ranging in size from large-scale multi-turbine wind farms to small-scale single-turbine wind-diesel hybrid systems.</li> <li><b>Small Hydro Project Model</b> for central-grid and isolated-grid connected projects, ranging in size from multi-turbine small and mini hydro installations to single-turbine micro hydro systems.</li> <li><b>Solar Water Heating Project Model</b> for domestic hot water, industrial process heat and swimming pools, ranging in size from small residential systems to large scale commercial, institutional and industrial systems.</li> </ol> | 2  | 0                            | 8        |
| 2   | <b>PVSyst</b><br>(i) Design and simulate grid-connected solar PV power plant for two sites with different latitudes under fixed tilt, seasonal tilt and   | 2  | 0                            | 12       |



|  |   |    |   |    |
|--|---|----|---|----|
|  | tracking.<br>a. Analyse average monthly performance ratio and energy production<br>b. Analyse impact of thermal losses for silicon and thin-film technologies<br>c. Analyse share losses for both the locations.<br>(ii) Design and simulate Rooftop PV system for off grid application for a household |    |   |    |
| <b>3</b>   | <b>Wind Atlas Analysis and Application Program (WAsP)</b><br>(i) Simulate and analyse grid-connected a wind turbine for two sites.<br>(ii) Design and simulate grid-connected wind farm for power generation.   | 2  | 0 | 8  |
| <b>4</b>   | <b>System Advisor Model</b><br>(i) Design and simulate solar thermal system for industrial process heat application for two sites with different latitudes<br>(ii) Design and simulate different types of concentrator solar thermal power plants   | 1  | 0 | 8  |
| <b>5</b>   | <b>HOMER</b><br>(i) Design and simulate an electrical system for a typical village using more than two renewable energy sources and technologies  | 2  | 0 | 8  |
| <b>6</b>   | <b>Power System Simulation for Engineering (PSS/E)</b><br>(i) Create and simulate a entire system in PSS/E<br>(ii) Determining the voltages, currents, and real and reactive power flows in a system under a given load conditions<br>(iii) Perform stability analysis in PSS/E                         | 2  | 0 | 8  |
| <b>7</b>   | <b>EnergyPlus</b><br>(i) Run Pre-Defined Building with no windows<br>(ii) Designing windows (size, material glazing, and position, etc)<br>(iii) Design lighting and air-condition a pre-defined building with windows  | 2  | 0 | 6  |
|  | <b>Total</b>  | 13 | 0 | 58 |
| <b>Evaluation criteria</b><br>Test 1: Performance (preparing the simulation and getting results closer to the expected spread over the entire semester) - 30%<br>Test 2: Viva-voce (at the end of the semester) - 30%<br>Test 3: Practical Exam (at the end of the semester) - 20%<br>Test 4: Practical Records (spread over the entire semester) - 20%  |   |    |   |    |
| <b>Learning outcomes:</b><br><br>After completing this course students will be able to <ul style="list-style-type: none"> <li>▪ Design of renewable energy power plants by optimum sizing of components (Test 1, 2, 3 and 4)</li> <li>▪ Simulate different types of energy systems to evaluate their energy performance (Test 1, 2, 3 and 4)</li> <li>▪ Integrate different technologies to create hybrid systems and evaluate their performance (Test 2 and 3)</li> <li>▪ Perform financial analysis of different RE technologies (Test 2 and 4)</li> <li>▪ Simulate a complete electrical system and carry out power flow analysis (Test 1 and 4)</li> </ul> |   |    |   |    |

**Pedagogical approach:**

Classroom lecture and computational laboratory work

**Materials:**

Leng, G., Meloche, N., Monarque, A., Painchaud, G., Thevenard, D., Ross, M., & Hosette, P. (2004). Clean Energy Project Analysis: RETScreen Engineering & Cases Textbook-Photovoltaic Project Analysis. *CANMET Energy Technology Center*.

Mermoud, A., & Wittmer, B. (2014). PVSYST user's manual. *Switzerland*.

Mortensen, N. G. (2007). Getting started with WASP 9. Risø-I-2571 (EN), Risoe National Laboratory, Technical University of Denmark, Roskilde.

Blair, N., Dobos, A., Freeman, J., Neises, T., Wagner, M., Ferguson, T., ... and Janzou, S. (2014). System advisor model, sam 2014.1. 14: General description. *NREL Rep. No. TP-6A20-61019, Natl. Renew. Energy Lab. Golden, CO, 13*.

Energy, H. O. M. E. R. (2011). Getting Started Guide for HOMER Legacy (Version 2.68). *HOMER Energy: Boulder, Colorado*.

Siemens, P. T. I. (2010). PSS/E User-Manual. *Version 33.4*

U.S. Department of Energy (2017) EnergyPlus Documentation  
<https://energyplus.net/documentation>

**Additional information (if any): NA****Student responsibilities:**

Attendance, feedback, discipline: as per university rules.

Softwares shall be available in the designated laboratory and university would not provide the software for your personal use.

**Course Reviewers**

3. Professor S. K. Samdarshi, Centre for Energy Engineering, Central University of Jharkhand, Ranchi
4. Professor Jyotirmay Mathur, Centre for Energy & Environment Malaviya National Institute of Technology Jaipur

| <b>Course title:</b> Grid Integration of Renewable Energy  |  |   |                      |                           |
|--|--|---|----------------------|---------------------------|
| <b>Course code:</b> ENR 143  |  | <b>No. of credits:</b> 3                  | <b>L-T-P:</b> 38-4-0 | <b>Learning hours:</b> 42 |
| <b>Pre-requisite course code and title (if any):</b> NA  |  |   |                      |                           |
| <b>Department:</b> Department of Energy and Environment  |  |   |                      |                           |
| <b>Course coordinator:</b> Dr. Naqui Anwer   |  | <b>Course instructor:</b> Dr. Naqui Anwer |                      |                           |
| <b>Contact details:</b> naqui.anwer@terisas.ac.in  |  |   |                      |                           |
| <b>Course type:</b> Elective   |  | <b>Course offered in:</b> Semester 3      |                      |                           |
| <b>Course description</b>  |  |   |                      |                           |
| <p>The characteristics and behaviour of power systems changes when the share of variable energy increase in the total mix. With the increase in penetration from renewable energy sources, the dynamics of the existing electricity infrastructure must be understood. This course provides a platform for strong understanding related to the phenomenon of integrating renewable energy sources. The course is focussed on causes, effects and recovery measures when power from renewable energy sources are injected to the grid.</p>                        |  |   |                      |                           |
| <b>Course objectives</b>   |  |   |                      |                           |
| <p>The objective of this course is to provide:</p> <ul style="list-style-type: none"> <li>▪ A strong understanding of power systems, their operation and control focussed on the issues related to the integration of distributed renewable generation into the network.</li> <li>▪ Strong foundation for power system equipments used for integration.</li> <li>▪ Detailed knowledge about power quality and its management along with approaches for grid stabilization.</li> <li>▪ Deep understanding about integration techniques for RE sources.</li> </ul> |  |   |                      |                           |
| <b>Course contents</b>   |  |   |                      |                           |
| <b>Module</b>  | <b>Topic</b>   | <b>L</b>                                  | <b>T</b>             | <b>P</b>                  |
| 1  | <b>Introduction</b><br>Various techniques of utilizing power from renewable energy sources, concept of nano/micro/mini grid. Need of integrating large renewable energy sources, issues related to integration of large renewable energy sources, rooftop plants. Concept of VPP.  | 4   | 0                    | 0                         |
| 2  | <b>Power system equipments for grid integration</b><br><b>Synchronous generator:</b> synchronization/integration to existing grid, load sharing during parallel operation, stability (swing equation and solution)<br><b>Induction Generator:</b> working principle, classification, stability due to variable speed and counter measures<br><b>Power Electronics:</b> need of power electronic equipments in grid integration, converter, inverter, chopper, ac regulator and cyclo-converters for AC/DC conversion | 12  | 2                    | 0                         |
| 3  | <b>Power quality and management</b><br>THD, voltage sag, voltage swell, frequency change and its effects, network voltage management, frequency management, system protection, grid codes  | 6   | 0                    | 0                         |

|          |  |           |          |          |
|----------|--|-----------|----------|----------|
| <b>4</b> | <b>Grid stabilization</b><br>Scheduling and dispatch, Forecasting, reactive power and voltage control, frequency control, operating reserve, storage systems, electric vehicles<br>Ancillary services in Indian Electricity Market (regulatory aspect), CERC and CEA orders (technical and safety standards)                                   | 6         | 0        | 0        |
| <b>5</b> | <b>Integration of alternate sources of energy</b><br>Introduction, principles of power injection: converting technologies, power flow; instantaneous active and reactive power control approach; integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection | 8         | 0        | 0        |
| <b>6</b> | <b>Case studies</b><br>Based on synchronous/induction generator for peak demand reduction, grid connected PV system  | 2         | 2        |          |
|          | <b>Total</b>   | <b>38</b> | <b>4</b> | <b>0</b> |

**Evaluation criteria**

Test 1: Assignments (after completion of modules 1, and 2) - 10%

Test 2: Written test (after completion of modules 3 and 4) - 20%

Test 3: Written test (after completion of modules 5 and 6) - 20%

Test 4: Written test (at the end of the semester, after completion of all the modules) - 50%

**Learning outcomes:**

On successful completion of this course, students should be able to:

- Apply advanced knowledge of electrical power system operations and control to analyse the challenges and opportunities for distributed renewable generation in both large interconnected grid and microgrid settings. (Test 1, 2, 3 and 4)
- Assess renewable energy applications and projects in the context of integration into both the physical and economic electricity markets. (Test 1 and 2)
- Describe the principles and requirements of the next generation future power network, incorporating distributed generation and storage and demand management. (Test 2 and 3)
- Understand the principles, power and limitations of complex power networks incorporating distributed generation and storage. (Test 1, 2, 3 and 4)

**Pedagogical approach:**

A combination of class-room interactions, group discussion and presentations, tutorials, practical and assignments.

Students' interaction with industry experts. Delivery of expert lectures by the professionals working on regulatory bodies and REMCs.

**Materials****Reference books**

Integration of Alternative sources of Energy, Felix A. Farret and M. Godoy Simoes, IEEE Press – Wiley-Interscience publication, 2006.

Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P.Kothari, CRC Press (Taylor & Francis group), 2017

Renewable Energy Grid Integration, Marco H. Balderas, Nova Science Publishers, New York,

2009.

Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow, IET Power and Energy Series 50 (IET digital library), 2007

Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, John Wiley & Sons, New York, 2013 (3<sup>rd</sup> edition)

Power Electronics: Circuits, Devices, and Applications. M.H.Rashid, Pearson Education India, 2013

Advanced power system analysis and dynamics, L.P.Singh, New age international publishers, 2017

### **Suggested readings:**

Solar Energy: Principles of Thermal Collection and Storage, S.P. Sukhatme and J. Nayak, Tata McGraw Hill, 2008(3<sup>rd</sup> edition)

Renewable Energy Engineering and Technology – A Knowledge Compendium, V.V.N. Kishore, TERI Press, 2008.

Analysis of demand response and wind integration in Germany's electricity market, M. Klobasa, IET Renew. Power Generation., Vol. 4, No.1, pp. 55–63 55, 2010.

Impact of wind power on the power system imbalances in Finland, A. Helander<sup>1</sup>, H. Holttinen, J. Paatero, IET Renew. Power Generation., Vol. 4, No. 1, pp. 75–84, 2010.

Comparative analyses of seven technologies to facilitate the integration of fluctuating renewable energy sources, B.V.Mathiesen H. Lund, IET Renew. Power Generation., Vol. 3, NO. 2, pp. 190–204, 2009.

Advanced grid requirements for the integration of wind farms into the Spanish transmission system, Morales<sup>1</sup>, X. Robe<sup>1</sup>, M. Sala, P. Prats, C. Aguerri, E. Torres, IET Renew. Power Generation., Vol. 2, No. 1, pp. 47–59, 2008.

Impact of widespread photovoltaic generation on distribution systems, M. Thomson and D.G. Infield, IET Renew. Power Generation, Vol. 1, No.1, pp. 33–40, 2007.

Teri Mini Grid Project at Gual Pahari.

### **Additional information (if any): NA**

### **Student responsibilities**

Adopt peer learning and knowledge sharing within the class

Attendance, feedback, discipline: as per university rules

### **Course reviewers:**

1. Dr. Sukumar Mishra, Professor, IIT Delhi
2. Dr. Indradip Mitra, Senior technical Advisor, GIZ GmbH, Germany

| <b>Course title:</b> Waste to Energy   |  |                          |  |                           |
|--|--|--------------------------|--|---------------------------|
| <b>Course code:</b> ENR 187  |  | <b>No. of credits:</b> 2 | <b>L-T-P:</b> 28-00--00                          | <b>Learning hours:</b> 28 |
| <b>Pre-requisite course code and title (if any):</b> NA  |  |                          |  |                           |
| <b>Department:</b> Department of Energy and Environment  |  |                          |  |                           |
| <b>Course coordinator:</b> Dr. Priyanka Kaushal  |  |                          | <b>Course instructor:</b> Dr. Lakshmi Raghupathy |                           |
| <b>Contact details:</b>  |  |                          |  |                           |
| <b>Course type:</b> Elective   |  |                          | <b>Course offered in:</b> Semester 3             |                           |
| <b>Course description:</b><br>The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is designed to provide an understanding of the various aspects of Waste to Energy. The various sources of waste generation is analysed with a focus on its potential for energy production. The need for characterization of wastes will be discussed along with the existing norms for waste utilization for alternate energy source. Various Technological options available for the production of energy form waste will delineated along with economics of using alternate sources. Case studies will be discussed to provide a better understanding of the concepts of “ <b>Waste to Energy</b> ” in the Indian context. |  |                          |  |                           |
| <b>Course objectives</b>   |  |                          |  |                           |
| <ul style="list-style-type: none"> <li>▪ To enable students to understand of the concept of Waste to Energy.</li> <li>▪ To link legal, technical and management principles for production of energy form waste.</li> <li>▪ To learn about the best available technologies for waste to energy.</li> <li>▪ To analyze of case studies for understanding success and failures.</li> <li>▪ To facilitate the students in developing skills in the decision making process.</li> </ul>   |  |                          |  |                           |
| <b>Course contents</b>   |  |                          |  |                           |
| Module   | Topic  | L                        | T  | P                         |
| 1  | <b>Introduction</b><br>The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source.  | 2                        |  |                           |
| 2  | <b>Waste Sources &amp; Characterization</b><br><br>Waste production in different sectors such as domestic, industrial, agriculture, post-consumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria. | 2                        |  |                           |
| 3  | <b>Technologies for Waste to Energy</b><br>Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation.<br>Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies.  | 4                        |  |                           |
| 4  | <b>Waste to Energy Options</b><br>Landfill gas, collection and recovery.<br>Refuse Derived Fuel (RDF) – fluff, briquettes, pellets.<br>Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers.   | 4                        | 2  |                           |

|   |  |    |   |  |
|---|--|----|---|--|
|   | <p>Conversion of wastes to fuel resources for other useful energy applications.</p> <p>Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery.</p> <p>Energy Recovery from wastes and optimization of its use, benchmarking and standardization.</p> <p>Energy Analysis</p>  |    |   |  |
| 5   | <p><b>Case Studies</b> – Success/failures of waste to energy</p> <p>Global Best Practices in Waste to energy production distribution and use.</p> <p>Indian Scenario on Waste to Energy production distribution and use in India.</p> <p>Success and Failures of Indian Waste to Energy plants.</p> <p>Role of the Government in promoting ‘Waste to Energy’</p>   | 4  |   |  |
| 6   | <p><b>Centralized and Decentralized Waste to Energy Plants</b></p> <p>Waste activities – collection, segregation, transportation and storage requirements.</p> <p>Location and Siting of ‘Waste to Energy’ plants.</p> <p>Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry.</p> <p>Centralized and Decentralized Energy production, distribution and use.</p> <p>Comparison of Centralized and decentralized systems and its operations.</p> | 4  | 2 |  |
| 7   | <p><b>Waste To Energy &amp; Environmental Implications</b></p> <p>Environmental standards for Waste to Energy Plant operations and gas clean-up.</p> <p>Savings on non-renewable fuel resources.</p> <p>Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms.</p>   | 4  |   |  |
|   | <b>Total</b>   | 24 | 4 |  |
| <p><b>Evaluation criteria:</b></p> <p>Test 1: Assignment (after completion of modules 1, 2 and 3) - 20%</p> <p>Test 2: Case Studies (after completion of module 5) - 20%</p> <p>Test 3: Written test (after completion of module 4) - 20%</p> <p>Test 4: Written test (after completion of modules 6 and 7) - 40%</p>   |  |    |   |  |
| <p><b>Learning outcomes:</b></p> <p>On successful completion of this course the students will be able to:</p> <ul style="list-style-type: none"> <li>▪ Apply the knowledge about the operations of Waste to Energy Plants. (Test 1 and 3)</li> <li>▪ Analyse the various aspects of Waste to Energy Management Systems. (Test 3)</li> <li>▪ Carry out Techno-economic feasibility for Waste to Energy Plants. (Test 2)</li> <li>▪ Apply the knowledge in planning and operations of Waste to Energy plants. (Test 3 and 4)</li> </ul> |  |    |   |  |
| <p><b>Pedagogical approach:</b></p> <p>A combination of class-room interactions, group discussion and presentations, tutorials and assignments</p>  |  |    |   |  |

**Materials:****Recommended readings**

Industrial and Urban Waste Management in India, TERI Press.

Wealth from Waste: Trends and Technologies by Banwari Lal and Patwardhan, TERI Press.

Fundamentals of waste and Environmental Engineering, S.N Mukhopadhyay, TERIPress.

Gazette Notification on Waste Management Rules 2016.

CPCB Guidelines for Co-processing in Cement/Power/Steel Industry

Waste-to-Energy in Austria – White Book – Figures, Data Facts, 2<sup>nd</sup> edition , May 2010

Report of the task Force on Waste to Energy, Niti Ayog (Formerly Planning Commission) 2014.

Municipal Solid Waste Management Manual, CPHEEO, 2016

**Reference Books/Journals:**

[Environmental and Resource Economics](#)

[Environmental Monitoring and Assessment](#)

[Journal of Environmental Assessment Policy and Management](#)

Reference papers and journals will also be given in class.

**Websites:**

[www.envfor.nic.in](http://www.envfor.nic.in)

[www.cpcb.nic.in](http://www.cpcb.nic.in)

[www.mnre.gov.in](http://www.mnre.gov.in)

[www.eai.in/ref/ae/wte/typ/clas/india\\_industrial\\_wastes.html](http://www.eai.in/ref/ae/wte/typ/clas/india_industrial_wastes.html)

[www.teriin.org/projects/green/pdf/National-Waste.pdf](http://www.teriin.org/projects/green/pdf/National-Waste.pdf)

**Additional information (if any):** There will be interactive sessions during the course.

**Student responsibilities:**

Attendance, timely feedback, discipline: as per university rules, adopt peer learning and knowledge sharing within the class

**Reviewers**

1. Dr Suneel Pande, Senior Fellow & Director Environment TERI, IHC, New Delhi
2. Dr Dinesh Pant, Fellow, Division Energy – Environment Technology, TERI, IHC, New Delhi
3. Mr Ulhas Parlikar, Dy Head Geocycle India –ACC Limited, Mumbai



|  |  |   |                           |          |
|--|--|---|---------------------------|----------|
| <b>Course title: Solar Thermal Power Generation</b>  |  |   |                           |          |
| <b>Course code: ENR 147</b>  | <b>No. of credits: 3</b>   | <b>L-T-P: 36-2-8</b>                            | <b>Learning hours: 46</b> |          |
| <b>Pre-requisite course code and title (if any):</b>   |  |   |                           |          |
| <b>Department:</b> Department of Energy and Environment  |  |   |                           |          |
| <b>Course coordinator:</b> Dr. Som Mondal  |  | <b>Course instructor:</b> Prof. Subhash Mullick |                           |          |
| <b>Contact details:</b> som.mondal@teriuniversity.ac.in  |  |   |                           |          |
| <b>Course type:</b> Elective   |  | <b>Course offered in:</b> Semester 3            |                           |          |
| <b>Course description:</b>   |  |   |                           |          |
| <p>The course is focused on techno-economics of power generation through solar thermal technology. Different types of collectors used for concentrating solar radiation and the fundamental principles along with comparative performance characteristics are discussed in detail. Design of power generation unit along with balance of system such as tracking mechanism, heat transfer fluid selection and thermal energy storage is covered in the course. Case studies and emerging technologies related to solar thermal power generation are also discussed. Finally, implementation of solar thermal power projects and their economic analysis is covered in this course.</p> |  |   |                           |          |
| <b>Course objectives:</b>  |  |   |                           |          |
| The objective of the course is to  |  |   |                           |          |
| <ul style="list-style-type: none"> <li>▪ Develop a detailed understanding of design and evaluation solar thermal power plants.</li> <li>▪ Provide economic analysis and implementation of solar thermal power projects.</li> </ul>   |  |   |                           |          |
| <b>Course contents</b>   |  |   |                           |          |
| <b>Module</b>  | <b>Topic</b>   | <b>L</b>  | <b>T</b>                  | <b>P</b> |
| 1  | <b>Introduction:</b><br>Overview of solar thermal power generation, Possibility of thermal energy storage, hybridization with solar thermal power plant  | 2   | 0                         | 0        |
| 2  | <b>Solar radiation review:</b><br>Models for radiation analysis and beam radiation calculations  | 4   | 0                         | 0        |
| 3  | <b>Solar concentrators:</b><br>Comparison of concentrators and flat plate collectors, Performance characteristics.<br>Comparison of line focus and point focus concentrators (one-directional and two directional focusing). Image formation and image enlargement due to errors.<br>Second Law of thermodynamics for solar concentrators.<br>Optical losses in solar concentrators. Intercept factor. Tracking & Non-tracking solar concentrators.<br>Parabolic trough, paraboloidic dish: continuous type and Fresnel type, Compound parabolic concentrators | 6   | 0                         | 0        |
| 4  | <b>Tracking:</b><br>Tracking requirements for different concentrator types and mechanisms: Single axis and double axis tracking, comparison.   | 2   | 0                         | 0        |
| 5  | <b>Solar thermal technologies:</b><br>Solar Parabolic trough: design considerations, thermal design of receivers. Possibilities with steam power plant and Organic Rankine   | 10  | 0                         | 0        |

|  |   |           |          |          |
|--|---|-----------|----------|----------|
|  | <p>cycle</p> <p>Solar parabolic dish: design considerations, Sterling engine, Brayton cycle (tracking and control system)</p> <p>Solar tower concept and design: tower and heliostat, thermal losses, receiver types, (tracking and control system)</p> <p>Product/technology overview for the above technologies</p>                                       |           |          |          |
| 6  | <p><b>Heat transfer fluids and thermal energy storage systems:</b></p> <p>Solar fraction and solar multiple. Impact of thermal storage.</p> <p>Continuously operating steam power plants with augmentation by solar thermal energy (in energy conserving or power boosting mode).</p> <p>Impact of Cogeneration (or CHP) on solar thermal power plants.</p> | 6         | 0        | 0        |
| 7  | <p><b>Other technologies:</b></p> <p>Linear Fresnel Reflector Collector, Solar chimney, Supercritical carbon-di-oxide cycle for solar power</p>   | 2         | 0        | 0        |
| 8  | <p><b>Case studies</b></p>  | 2         | 2        | 0        |
| 9  | <p><b>Solar thermal power plants:</b></p> <p>Sizing of plants.</p> <p>Testing of Receivers</p> <p>Engineering design of a solar thermal power plant</p> <p>Site selection and resource assessment</p> <p>Power evacuation, Performance evaluation</p> <p>O&amp;M, PPA.</p> <p>Economics of CSP plant</p>  | 2         | 0        | 8        |
|  | <p><b>Total</b></p>   | <b>36</b> | <b>2</b> | <b>8</b> |
| <p><b>Evaluation criteria:</b></p> <p>Test 1: Assignments (after completion of module 8) - 20%</p> <p>Test 2: Written test (after completion of modules 1, 2, 3 and 4) - 30%</p> <p>Test 3: Written test (after completion of modules 5, 6, 7 and 9) - 50%</p>   |   |           |          |          |
| <p><b>Learning outcomes:</b></p> <p>After completing this course, a student will be able to:</p> <ul style="list-style-type: none"> <li>▪ Develop a comprehensive understanding on different collector technologies and their comparative performance characteristics (Test 2 and 3)</li> <li>▪ Design a solar thermal power plant through appropriate selection of collector, receiver, power cycles, heat transfer fluid and tracking mechanism (Test 1)</li> <li>▪ Carry out the economic analysis of a solar thermal power plant and develop understanding on implementation process of a solar thermal power project (test 1, 2 and 3)</li> </ul> |   |           |          |          |
| <p><b>Pedagogical approach:</b></p> <p>A combination of class-room interactions, group discussion and presentations, tutorials, practical and assignments</p>  |   |           |          |          |

**Materials:****Reference books:**

Solar Engineering of Thermal Processes, J.A. Duffie and W.A. Beckman, 3rd ed.(John Wiley & Sons, 2006)

S.P. Sukhatme and J. Nayak: Solar Energy: Principles of Thermal Collection and Storage, Third Edition (Tata McGraw Hill, 2008)

Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. V.V.N. Kishore (TERI Press, 2008).

**Additional information (if any):****Student responsibilities:**

Adopt peer learning and knowledge sharing within the class

Attendance, feedback, discipline: as per university rules

**Course reviewers:**

1. Prof. J. K. Nayak, Professor, Energy Science & Engineering, IIT Bombay
2. Mr. S. K. Singh, Director General, National Institute of Solar Energy

| <b>Course title:</b> Solar Photovoltaic Power Generation   |   |  |                           |   |
|--|---|--|---------------------------|---|
| <b>Course code:</b> ENR 145  | <b>No. of credits:</b> 3  | <b>L-T-P:</b> 36-4-4                     | <b>Learning hours:</b> 44 |   |
| <b>Pre-requisite course code and title (if any):</b> ENR 151   |   |  |                           |   |
| <b>Department:</b> Department of Energy and Environment  |   |  |                           |   |
| <b>Course coordinator:</b> Dr. Som Mondal  |   | <b>Course instructor:</b> Dr. Som Mondal |                           |   |
| <b>Contact details:</b> <a href="mailto:som.mondal@terisas.ac.in">som.mondal@terisas.ac.in</a>   |   |  |                           |   |
| <b>Course type:</b> Elective   |   | <b>Course offered in:</b> Semester 3     |                           |   |
| <b>Course description:</b><br>Solar Photovoltaic technology is used for direct conversion of sunlight to electricity with advantages of low gestation period, ease of installation, modular nature and minimum maintenance. The course is focused on techno-economics of power generation through solar PV technology. The course starts with the essence of solar PV power generation policies. It is followed by various aspects of system specification, design, project implementation and operation & maintenance. The course offers a blend of technical expertise required for design and operation of a solar PV power plant and the understanding of the management aspects required to implement and commission a PV power plant. It also covers the economic analysis of a PV project and its environmental benefits. |   |  |                           |   |
| <b>Course objectives:</b><br>The objective of the course is: <ul style="list-style-type: none"> <li>▪ To develop a comprehensive technological understanding in solar PV system components</li> <li>▪ To provide in-depth understanding of design parameters to help design and simulate the performance of a solar PV power plant</li> <li>▪ To pertain knowledge about planning, project implementation and operation of solar PV power generation.</li> </ul>   |   |  |                           |   |
| <b>Course contents</b>   |   |  |                           |   |
| Module   | Topic   | L  | T                         | P |
| 1  | <b>Introduction</b><br>Global solar PV deployment status, Solar policy in India – rooftop and ground mounted, Current Central and State schemes and targets<br>Review of solar radiation components, radiation on tilted surface  | 4  |                           |   |
| 2  | <b>PV system</b><br><b>PV module technology:</b> c-Si, Thin-film technology, response to weather parameters, commercial module ratings, standards, module reliability<br><b>Inverter technology:</b> Inverter technologies, types of inverters, inverter selection, voltage levels, performance, power quality<br><b>Balance of system/plant:</b> Module mounting structure, tracking system, Cabling and electrical design, single line diagrams, metering<br><b>Safety systems:</b> Hotspot, Blocking and bypass diodes, surge protection, PID and its protection, Lighting protection, anti-islanding<br><b>Battery technologies:</b> Introduction to battery, battery technologies, | 10                                       |                           |   |

|  |  |    |   |   |
|--|--|----|---|---|
|  | standalone system and utility scale storage<br><b>Types of PV systems:</b> Design considerations for standalone and grid-connected plants, rooftop and ground mounted, floating solar plant, BIPV  |    |   |   |
| 3  | <b>PV plant design</b><br><b>Rooftop PV plant:</b> design consideration, types of mounting structures, standards<br><b>Ground mounted PV plant:</b> Array design and PV panel mounting, electrical layout, standards<br><b>Performance parameter:</b> Losses in solar PV power plant, Yield, Capacity Utilization Factor and Performance Ratio<br>Design exercises using PVsyst for ground mounted and rooftop plants with shadow analysis | 4  | 2 | 4 |
| 4  | <b>PV project development</b><br>Preliminary site survey and feasibility study, statutory clearances and permits, Different modes of project development, PPA and evacuation planning, DPR<br>Project schedule, procurement schedule, civil and electrical works, installation of module and inverter<br>Grid-synchronization and power evacuation, Testing and acceptance<br>Concept of Mega Solar Parks                                  | 6  |   |   |
| 5  | <b>Operation and maintenance</b><br>Monitoring of PV plant, Best practices in operation, cleaning and maintenance  | 4  |   |   |
| 6  | <b>Case Studies based on module 1, 2, 3, 4 and 5</b>   | 4  |   |   |
| 7  | <b>Estimation of energy payback and environmental benefits of SPV power plant:</b><br>Performance analysis and estimation of energy payback period for SPV power plant – rooftop, ground-mounted, stand alone and small-scale & large-scale power plant scenarios, assessment of carbon footprints and carbon credit calculation, estimating CO <sub>2</sub> mitigation potential  | 4  | 2 |   |
|  | <b>Total</b>   | 36 | 4 | 4 |
| <b>Evaluation criteria:</b><br>Test 1: Assignments (after completion of module 6) - 20%<br>Test 2: Written test (after completion of modules 1, 2 and 3)- 15%<br>Test 3: Written test (after completion of modules 4 and 5) - 15%<br>Test 4: Written test (at the end of the semester after completion of modules 7) - 50%   |  |    |   |   |
| <b>Learning outcomes:</b><br>After completing this course, a student will be able to: <ul style="list-style-type: none"> <li>▪ Develop understanding on the PV plant design and select suitable technologies (Test 2)</li> <li>▪ Design and simulate a PV power plant using software tool (Test 1)</li> <li>▪ Plan project implementation, operation and maintenance (Test 2, 3 and 4)</li> <li>▪ Carry out techno-economic-environmental performance evaluation of a solar PV power plant (Test 3 and 4)</li> </ul> |  |    |   |   |

**Pedagogical approach:**

A combination of class-room interactions, expert lecture, assignment, tutorial, practical and case study

**Reference books:**

Handbook of photovoltaic science and engineering, ed. A. Luque and S. Hegedus (John Wiley and Sons, 2010)

Solar Photovoltaics – Fundamentals, Technologies and Applications, C. S. Solanki, 2nd ed. (PHI Learning, 2011)

Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. V.V.N. Kishore (TERI Press, 2008).

Photovoltaic system engineering, R. A. Messenger and A. Abtahi, 3rd ed. (CRC Press, 2010)

Grid connected PV systems design and installation, GSES (GSES India Sustainable Energy, 2013)

**Additional information (if any):****Student responsibilities:**

Adopt peer learning and knowledge sharing within the class

Attendance, feedback, discipline: as per university rules

**Course reviewers:**

1. Dr. B. D. Sharma, Chief Technical Officer and Vice President, JBM Solar, Gurgaon
2. Mr. Dwipen Boruah , Managing Director, GSES, New Delhi



## **Department of Energy and Environment**

### **Guidelines for ENR 105: Independent Study**

The independent study is a three-credit course offered to the students registered for the MTech in Renewable Energy Engineering and Management (REEM). The student will conduct a study under the supervision of a faculty from TERI School of Advanced Studies. The course carries three (3) credits and should be conducted under the following guidelines:

#### **1. Eligibility**

1.1 Students having a CGPA of 7.5 and above are eligible to register for this course.

#### **2. Registration to the course**

2.1. Students interested in registering for the course ENR 105 (Independent study) should get consent from the supervisor before they register for the course.

#### **3. Supervision**

3.1. The Supervisor can be any faculty from TERI School of Advanced Studies

#### **4. Submissions and evaluation timeline**

##### **4.1. Test 1: Synopsis [20%]**

4.1.1. Submission date: 2<sup>nd</sup> week of August. Presentation and submission of soft copy of synopsis

4.1.2. Evaluation: Evaluation by the supervisor and two faculty members.

4.1.3. Contents of synopsis: Both the presentation and synopsis document should have the following

- a. Title of the study (with name of student and supervisor)
- b. Rationale for the study and Research objectives (Maximum 3)
- c. Literature review
- d. Methodology
- e. Expected Outcome
- f. Time line
- g. References

##### **4.2. Test 2: Mid-term evaluation [20%]**

4.2.1. Presentation date: Last week of October

4.2.2. Mid-term evaluation by the supervisor and two faculty members.

##### **4.3. Test 3: Final evaluation [Presentation 30%: Report: 30%] (Final Report submission – 2<sup>nd</sup> week of December)**

4.3.1. Submission date: 4<sup>th</sup> week of November

4.3.2. Evaluation will be based on a presentation and a report

4.3.3. Presentation: Presentation made to supervisor and 2 additional faculty members

4.3.4. Report: Report submission at the end of the term evaluated by supervisor and a faculty member

- 4.3.5. Contents of report: The report should be around 40 pages. A detail on the contents is given below. Soft copy of the final report will be submitted to the course coordinator with a copy to the supervisor.

## **5. Learning outcomes**

**5.1.** After completing the course, the students will be able to:

- 5.1.1. Provide comprehensive knowledge about the topics of the study (Test 1)
- 5.1.2. Design and implement the concepts related to the study (Test 2 and 3)
- 5.1.3. Test the systems (if any) in with wholistic approach (Test 2 and 3)



**TITLE**

**Independent Study**

*Submitted by*

**NAME**  
**(Enrolment number)**



*For the partial fulfillment of the*

**Degree of Master of Technology in**  
**RENEWABLE ENERGY ENGINEERING AND MANAGEMENT**

*Submitted to*

Department of Energy and Environment  
TERI School of Advanced Studies

December 2018

**DECLARATION**

This is to certify that the work that forms the basis of this project “Title of report” is an original work carried out by me

I certify that all sources of data and information are fully acknowledged in the project report.

Name of the student

**ACKNOWLEDGEMENTS**

List of Tables  
List of Figures  
Abstract

1. Introduction
2. Study Area
3. Aim and Objectives
4. Methodology
5. Results and Discussions
6. Conclusions and Limitations
7. Future Scope of Work
8. References

|  |   |   |                      |                           |
|--|---|---|----------------------|---------------------------|
| <b>Course title:</b> Smart Grid  |   |   |                      |                           |
| <b>Course code:</b> ENR XXX  |   | <b>No. of credits:</b> 2                  | <b>L-T-P:</b> 28-0-0 | <b>Learning hours:</b> 28 |
| <b>Pre-requisite course code and title (if any):</b> NA  |   |   |                      |                           |
| <b>Department:</b> Department of Energy and Environment  |   |   |                      |                           |
| <b>Course coordinator:</b> Dr. Naqui Anwer   |   | <b>Course instructor:</b> Dr. Naqui Anwer |                      |                           |
| <b>Contact details:</b> naqui.anwer@terisas.ac.in  |   |   |                      |                           |
| <b>Course type:</b> Elective   |   | <b>Course offered in:</b> Semester 3      |                      |                           |
| <b>Course description</b>  |   |   |                      |                           |
| <p>The behaviour of existing electrical grid changes very fast and requires dynamic platforms to address the peculiarities related to increased penetration from renewable energy sources, possible inclusion of electric vehicles, ensuring energy security, open access and deregulation. The grid should be resilient enough to behave smartly. The time has come for the existing electric grid to become a smart grid by incorporating dynamic platforms of communication technologies superimposing over the existing electricity infrastructure. The course provides a platform for deep understanding of smart features of an electric grid.</p> |   |   |                      |                           |
| <b>Course objectives</b>   |   |   |                      |                           |
| <p>This course provides knowledge about</p> <ul style="list-style-type: none"> <li>▪ Smart electric power grids, including definition, design criteria, technology and IoT.</li> <li>▪ Information processing and communications to the power grid.</li> <li>▪ Understanding the development of the smart grid,</li> <li>▪ Smart grid design, implementation, evaluation and management of smart electricity infrastructure.</li> </ul>  |   |   |                      |                           |
| <b>Course contents</b>   |   |   |                      |                           |
| <b>Module</b>  | <b>Topic</b>  | <b>L</b>                                  | <b>T</b>             | <b>P</b>                  |
| 1  | <b>Introduction</b><br>Indian smart grid policy. Basic concept and definition of smart grid. Smart grid architecture. Smart grid technologies. Properties of smart grid: flexibility, reliability, demand response and other performance parameters. DC smart micro grids.  | 4   | 0                    | 0                         |
| 2  | <b>Communication technologies</b><br>Generic model of communication network needed for Smart-grid, two way and real-time communication in power network, Introduction to different communication technologies available in the market (Latest standards. Emphasis on importance of interoperability and standardization of communication protocols), Matrix of different technologies against the smart-grid communication needs in a given utility environment, AMI, AMR & MDA: How it works and how it will help to; reduce | 8   | 0                    | 0                         |

|          |  |           |          |          |
|----------|--|-----------|----------|----------|
|          | peaks manage networks more efficiently and contribute towards smarter grids, Communication Standards IEC6150, Wide Area Situation awareness (WASA), Network stability  |           |          |          |
| <b>3</b> | <b>Smart meters</b><br>Introduction, technology, data management, energy monitoring, smart energy meter, Phasor Measurement Unit (PMU), smart metering infrastructure, data acquisition  | 4         | 0        | 0        |
| <b>4</b> | <b>Flexible AC transmission system (FACTS)</b><br>Congestion management and loadability enhancement, reactive power compensation, concept of series compensation, shunt compensation, FACTS: working principle, classification, series controllers, shunt controllers, series-series controllers, series-parallel controllers. | 6         | 0        | 0        |
| <b>5</b> | <b>IoT for power systems</b><br>Internet of things for electricity infrastructure and energy management. SCADA, Demand response, AMI, IoT aided smart grid, Big data for power system and introduction to data analytics.  | 4         | 0        | 0        |
| <b>6</b> | <b>Application of smart grid</b><br>Challenges being faced during implementation of smart grid. virtual power plants, Smart Utilities (case studies), Smart Grid Maturity Model (SGMM).  | 2         | 0        | 0        |
|          | <b>Total</b>   | <b>28</b> | <b>0</b> | <b>0</b> |

**Evaluation criteria**

Test 1: Assignments (after completion of module 1) - 10%  
 Test 2: Written test (after completion of modules 2 and 3) - 20%  
 Test 3: Written test (after completion of modules 3 and 4) - 20%  
 Test 4: Written test (after completion of modules 5 and 6) - 50%

**Learning outcomes:**

On successful completion of this course, students should be able to:

- Apply advanced knowledge of electrical power system operations and control to analyse the challenges and opportunities due to increased penetration of renewable energy sources. (Test 2 and 3)
- understand and conceptualize the design of smart grid by selecting appropriate communication technologies, implementing smart meter and FACTS. (Test 1, 2 and 3)
- Describe the principles and requirements of the next generation future power network (or smart grid), using the latest trends in IoT for power systems. (Test 4)

|   |
|---|
| <p><b>Pedagogical approach:</b><br/>A combination of class-room interactions, group discussion and presentations, tutorials, practical and assignments</p>  |
| <p><b>Materials</b></p> <p><b>Reference books</b><br/>James Momoh, “Smart Grid: Fundamentals of design and analysis”, John Wiley &amp; sons Inc, IEEE press 2012.<br/>Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley &amp; sons inc, 2015.<br/>Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed &amp; Efficient Energy”, Academic Press, 2012.<br/>Clark W.Gellings, “The smart grid: Enabling energy efficiency and demand response”, Fairmont Press Inc, 2009.</p> <p><b>Suggested readings:</b><br/>M.S.Hossain, N.A.Madloul, N.A.Rahim, J.Selvaraj, A.K.Pandey, Abdul FaheemKhan, “Role of smart grid in renewable energy: An overview”, Elsevier Journal of Renewable and Sustainable Energy Reviews, Volume 60, July 2016, pp. 1168-1184.<br/>P. Siano, “Demand response and smart grids—a survey”, Elsevier Journal of Renewable and Sustainable Energy Reviews, Volume 30, 2014, pp. 461-478.<br/>Xi Fang, Satyajayant Misra, Guoliang Xue, Dejun Yang, “Smart Grid — The New and Improved Power Grid: A Survey”, IEEE Communications Surveys &amp; Tutorials, Volume: 14, Issue: 4, Fourth Quarter 2012<br/>Murat Kuzlu, Manisa Pipattanasomporn, Saifur Rahman, “Communication network requirements for major smart grid applications in HAN, NAN and WAN”, Elsevier Journal of Computer Networks, Volume 67, 4 July 2014, pp. 74-88<br/>Yasir Saleem, Noel Crespi, Mubashir Husain Rehmani, Rebecca Copeland, “Internet of Things-aided Smart Grid: Technologies, Architectures, Applications, Prototypes, and Future Research Directions”, IEEE transaction on Networking and Internet Architecture, 2017</p> <p><b>Journals and Magazines:</b><br/>IEEE Transactions on Power Systems.<br/>IEEE Transaction on Smart Grid</p> |
| <p><b>Additional information (if any): NA</b></p>   |
| <p><b>Student responsibilities</b><br/>Adopt peer learning and knowledge sharing within the class<br/>Attendance, feedback, discipline: as per university rules</p>   |

**Course reviewers:**

1. Prof. Biswarup Das, IIT Roorkee
2. Dr. Chandan Kumar, IIT Guwahati