# DARBHANGA COLLEGE OF ENGINEERING

## DARBHANGA

**COURSE FILE**

**OF**

**Direct Energy Conversion**

**(EE 031828)**

**DEEPAK SINGH**

**ASSISTANT PROFESSOR**

**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING**

विज्ञान एवं प्रावैधिकी विभाग
Department of Science and Technology
Government of Bihar

**Vision of EEE**: - To bring forth engineers with an emphasis on higher studies and a fervour to serve national and multinational organizations and, the society.

**Mission of EEE: -**

M1: - To provide domain knowledge with advanced pedagogical tools and applications.

M2: - To acquaint graduates to the latest technology and research through collaboration with industry and research institutes.

M3: - To instil skills related to professional growth and development.

M4: - To inculcate ethical valued in graduates through various social-cultural activities.

**PEO of EEE**

**PEO 01** – The graduate will be able to apply the Electrical and Electrical Engineering concepts to excel in higher education and research and development.

**PEO 02** – The graduate will be able to demonstrate the knowledge and skills to solve real life engineering problems and design electrical systems that are technically sound, economical and socially acceptable.

**PEO 03** – The graduates will be able to showcase professional skills encapsulating team spirit, societal and ethical values.

**Program Outcomes of B.Tech in Electrical and Electronics Engineering**

**1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**5. Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

**6. The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**7. Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**8. Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**9. Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**12. Life-long learning**: Recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PSO of EEE**

**PSO 01** Students will be able to identify, formulate and solve problems using various software and other tools in the areas of Automation, Control Systems, Power Engineering and PCB designing.

**PSO 02** Students will be able to provide sustainable solutions to growing energy demands.

**Course Description**

This course introduces principles and technologies for converting heat into electricity via solid-state devices. The first part of the course discusses thermoelectric energy conversion and thermoelectric materials, thermionic energy conversion, and photovoltaic.

**Course Objectives**

To impart the knowledge of basics of different non-conventional types of power generation & power plants in detail so that it helps them in understanding the need and role of Non-Conventional Energy sources particularly when the conventional sources are scarce in nature.

After the completion of this course the students will be able to:

CO1: Remember the different kinds of energy sources.

CO2: Analyze the different technique and the method for extraction and conversion of energy from different sources.

CO3: Understand the problem that affect for the power loss in renewable energy.

CO4: Evaluation and analyze the efficiency and its characteristics of renewable energy sources.

**CO5:** Develop the efficient technique and tools for renewable energy.

**Mapping of CO's with PO's**

## CO-PO MAPPING

**PSO1.** Students should be able to identify, formulate and solve problems in the areas of automation, control systems and power engineering.
**PSO2.** Students will be able to provide sustainable solutions to growing energy demands.

| Sr. No. | Course Outcome | PO |
|---|---|---|
| 1. | **031828.1** Remember the different kinds of energy sources. | PO1, PO2, PO3, PO4, PO5, PO7, PO10, PSO1, PSO2. |
| 2. | **031828.2** Analyse the different technique and the method for extraction and conversion of energy from different sources. | PO1, PO2, PO3, PO4, PO5,PO7, PO8, PO10, PO11, PSO1 |
| 3. | **031828.3** Understand the problem that affect for the power loss in renewable energy. | PO1, PO2, PO3, PO4, PO5, PO7,PO8, PO9, PSO2 |
| 4. | **031828.4** Evaluation and analyse the efficiency and its characteristics of renewable energy sources. | PO1, PO2, PO3, PO4, PO5, PO7,PO10, PSO2. |
| 5. | **031828.5** Develop the efficient technique and tools for renewable energy. | PO1, PO2, PO3, PO4, PO5, PO6, PO7,PO9, PO11 PSO1,PSO2. |

| **Course Outcomes** | **PO1** Engineering knowledge | **PO2** Problem analysis | **PO3** Design/development of solutions | **PO4** Investigation | **PO5** Modern tool usage | **PO6** The engineer and society | **PO7** Environment and sustainability | **PO8** Ethics | **PO9** Individual and team work | **PO10** Communications | **PO11** Project management and finance | **PO12** Life-long learning | **PSO1** | **PSO2** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **031828.1** Remember the different kinds of energy sources. | 3 | 2 | 2 | 2 | 1 | | 2 | | | 1 | | | 1 | 2 |
| **031828.2** Analyse the different technique And the method for extraction and conversion of energy from different sources. | 3 | 3 | 3 | 3 | 1 | | 2 | 1 | | 2 | 1 | | 1 | 3 |
| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |

| | Engineering knowledge | Problem analysis | Design/development of solutions | Investigation | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communications | Project management and finance | Life-long learning | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **031828.3** Understand the problem that affect for the power loss in renewable energy. | 3 | 3 | 2 | 2 | 1 | | 3 | 1 | 1 | | | | | 2 |
| **031828.4** Evaluation and analyse the efficiency and its characteristics of renewable energy sources. | 2 | 2 | 1 | 1 | 1 | | 2 | | | 1 | | | | 2 |
| **031828.5** Develop the efficient technique and tools for renewable energy. | 2 | 1 | 3 | 1 | 2 | 1 | 2 | | 1 | | 1 | | 1 | 3 |

**B. Tech. VIII Semester (EEE)**

**EE- 031828 Direct Energy Conversion**

| L T P/D | Total | Max Marks: | 100 |
|---|---|---|---|
| 3-1-0 | 4 | Final Exam: | 70 Marks |
| | | Sessional: | 20 Marks |
| | | Internals: | 10 Marks. |

## Direct Energy Conversion

1. **UNIT 1: Introduction**: Energy sources, Energy conversion chart, Direct Energy Conversion (DEC) devices, General representation of DEC devices
2. **UNIT 2: Thermoelectric Power Generation**: Introduction, Thermoelectric effects, Thermodynamic analysis of thermoelectric generator, Maximum thermal efficiency and maximum power output, Single stage and multistage generators, thermoelectric materials, Applications.
3. **UNIT 3: Fuel Cells** : Introduction, Principle of fuel cell operation and different types of fuel-cells reactions, electrochemical thermodynamics, Relation of cell potential to thermodynamic variables, Cell efficiency, Polarization losses, Types of fuel cells, Performance characteristics, Applications.
4. **UNIT 4: Solar Cells** : Introduction, Basic theory of pn junction photovoltaic converters, Characteristics of solar radiation, Typical schematic representation of a solar cell and the idealized equivalent circuit, Basic characteristics, power and efficiency, Materials for photovoltaic conversion and cell fabrication, Silicon, Cadmium Sulphide and Gallium Arsenide cells, Application, System design methodology.
5. **UNIT 5: MHD Generator**: Introduction, Gaseous conductors, Seeding, MHD equations, Operating range of an MHD duct, Different types of MHD generators, Thermodynamic analysis of linear constant velocity MHD generator, Electrical power output and efficiency, Adiabatic efficiency, Introduction to liquid MHD generator.
6. **UNIT 6: Fusion Power**: Principles of fusion power production, Advantages of fusion power, Problems in achieving controlled thermonuclear reactions, Plasma confinement, heating and diagnostics, Fusion devices.
7. **UNIT 7: Wind Power**: Introduction to Wind Power Generation.

**Books:**


1. "Direct Energy Conversion" by M.All Kettani, Addison-Wesley, 1970.
2. "Direct Energy Conversion" by S.W.Angrist, Allyn & Bacon, Boston, 4th Edn., 1982.
3. "Direct energy Conversion" by S.L.Soo, Prentice Hall, 1968. 3 Reference

## Course Plan

| | | | |
|---|---|---|---|
| **Institute / College Name :** | DARBHANGA COLLEGE OF ENGINEERING | | |
| **Program Name** | B.Tech (EEE, 8th semester) | | |
| **Course Code** | 031828 | | |
| **Course Name** | DIRECT ENERGY CONVERSION | | |
| **Lecture / Tutorial (per week):** | 3/1 | **Course Credits** | 4 |
| **Course Coordinator Name** | MR. DEEPAK SINGH | | |

### 1. Scope and Objectives of the Course

To enable students to gain knowledge and understanding in the following aspects:

- **Remember** the different kinds of energy sources.
- **Analyze** the different technique and the method for extraction and conversion of energy from different sources.
- **Understand** the problem that affect for the power loss in renewable energy.
- **Evaluation** and analyze the efficiency and its characteristics of renewable energy sources.
- **Develop** the efficient technique and tools for renewable energy.

### 2. Textbooks

**TB1:** 'Direct Energy Conversion" by M.All Kettani, Addison-Wesley, 1970.

**TB2**: "Direct Energy Conversion" by S.W.Angrist, Allyn & Bacon, Boston, 4thEdn.,1982.

### 3. Reference Books

**RB1:** "Direct energy Conversion" by S.L.Soo, Prentice Hall, 1968.

### Other readings and relevant websites

| S.No. | **Link of Journals, Magazines, websites and Research Papers** |
|---|---|

| | |
|---|---|
| 1. | https://en.wikipedia.org/wiki/Direct_energy_conversion |
| 2. | http://www.dtic.mil/dtic/tr/fulltext/u2/627658.pdf |
| 3. | http://onlinelibrary.wiley.com/doi/10.1111/j.1559-3584.1979.tb04331.x/pdf |

## 4. Course Plan

| Lecture Number | Date of Lecture | Topics | Web Links for video lectures | Text Book / Reference Book / Other reading material | Page numbers of Text Book(s) |
|---|---|---|---|---|---|
| 1-4 | | **Introduction** | | TB1, RB1 | 1-20 |
| | | Energy sources, Energy conversion chart, Direct Energy Conversion (DEC) devices, General representation of DEC devices | https://www.youtube.com/watch?v=giXuabYgI3A | | |
| **Assignment-1** | | | | | |
| 5-11 | | **Thermoelectric Power Generation** | | RB1 | 76-98 |
| | | Introduction, Thermoelectric effects, Thermodynamic analysis of Thermoelectric generator, Maximum thermal efficiency and maximum power output, Single stage and multistage generators, Thermoelectric materials, Applications. | https://www.youtube.com/watch?v=9YLJ-Wrye8Q | https://www.electrical4u.com/thermoelectric-power-generators-or-seebeck-power-generation | |
| **Tutorial-1, Assignment-2** | | | | | |
| 12-18 | | **Fuel Cells** | | TB1, RB1 | 35-42 |
| | | Introduction, Principle of fuel-cell operation and different types of fuel-cells reactions, electrochemical thermo- | https://www.youtube.com/watch?v=mpHZWYpKDJg | http://nptel.ac.in/courses/108105066/9 | |

| | | | | | |
|---|---|---|---|---|---|
| | | dynamics, Relation of cell potential to thermodynamic variables, Cell efficiency, Polarization losses, Types of fuel cells, Performance characteristics, Applications. | | | |
| **Mid-Semester Exam (Syllabus covered from 1-20 lectures)** | | | | | |
| 19-25 | | **Solar Cells** | | TB1, RB1 | 43-56 |
| | | Introduction, Basic theory of p-n junction photovoltaic converters, Characteristics of solar radiation, Typical schematic representation of a solar cell and the idealized equivalent circuit, Basic characteristics, power and efficiency, Materials for photovoltaic conversion and cell fabrication, Silicon, Cadmium Sulphide and Gallium Arsenide cells, Application, System design methodology. | https://www.livescience.com/41995-how-do-solar-panels-work.html | https://www.sciencedirect.com/journal/solar-cells | |
| **Assignment-3** | | | | | |
| 26-35 | | **MHD Generator** | | TB1, RB1 | 110-143 |
| | | Introduction, Gaseous conductors, Seeding, MHD equations, Operating range of an MHD duct, Different types of MHD generators, Thermodynamic analysis of linear constant velocity MHD generator, Electrical power output and efficiency, Adiabatic efficiency, Introduction | https://www.youtube.com/watch?v=5Xb7uPAaCuc | https://en.wikipedia.org/wiki/Magnetohydrodynamic_generator | |

| | | | | | |
|---|---|---|---|---|---|
| | | to liquid MHD generator. | | | |
| **Tutorial-2, Assignment-4** | | | | | |
| 36-39 | | **Fusion Power** | | TB1, RB1 | 60-72 |
| | | Principles of fusion power production, Advantages of fusion power, Problems in achieving controlled thermonuclear reactions, Plasma confinement, heating and diagnostics, Fusion devices. | https://www.youtube.com/watch?v=LJZvFlo0iNs | https://en.wikipedia.org/wiki/Fusion_power | |
| **Tutorial-3, Assignment-5** | | | | | |
| 40-42 | | **Wind Power** | | TB2 | 23-38 |
| | | Introduction to Wind Power Generation. | https://www.youtube.com/watch?v=GExTwRNkQBg | http://nptel.ac.in/courses/108105058/24 | |

1. **Evaluation Scheme:**

| | | |
|---|---|---|
| Component 1 | Mid Semester Exam | 20 |
| Component 2 | Assignment Evaluation | 10 |
| Component 3** | End Term Examination** | 70 |
| | **Total** | **100** |

**** The End Term Comprehensive examination will be held at the end of semester. The mandatory requirement of 75% attendance in all theory classes is to be met for being eligible to appear in this component.

## SYLLABUS

| Topics | No of lectures | Weightage |
|---|---|---|
| Energy sources, Energy conversion chart, Direct Energy Conversion (DEC) devices, General representation of DEC devices | 4 | 10% |
| Introduction, Thermoelectric effects, Thermodynamic analysis of Thermoelectric generator, Maximum thermal efficiency and | 7 | 16% |

| | | |
|---|---|---|
| maximum power output, Single stage and multistage generators, Thermoelectric materials, Applications. | | |
| Introduction, Principle of fuel-cell operation and different types of fuel-cells reactions, electrochemical thermo-dynamics, Relation of cell potential to thermodynamic variables, Cell efficiency, Polarization losses, Types of fuel cells, Performance characteristics, Applications. | 7 | 16% |
| Introduction, Basic theory of p-n junction photovoltaic converters, Characteristics of solar radiation, Typical schematic representation of a solar cell and the idealized equivalent circuit, Basic characteristics, power and efficiency, Materials for photovoltaic conversion and cell fabrication, Silicon, Cadmium Sulphide and Gallium Arsenide cells, Application, System design methodology. | 7 | 16% |
| Introduction, Gaseous conductors, Seeding, MHD equations, Operating range of an MHD duct, Different types of MHD generators, Thermodynamic analysis of linear constant velocity MHD generator, Electrical power output and efficiency, Adiabatic efficiency, Introduction to liquid MHD generator. | 10 | 25% |
| Principles of fusion power production, Advantages of fusion power, Problems in achieving controlled thermonuclear reactions, Plasma confinement, heating and diagnostics, Fusion devices. | 4 | 10% |
| Introduction to Wind Power Generation. | 3 | 7% |

**This Document is approved by:**

| **Designation** | **Name** | **Signature** |
|---|---|---|
| Course Coordinator | Mr.Deepak Singh | |
| H.O.D | Mr. Prabhat Kumar | |
| Principal | Dr. Achintya | |

**Evaluation and Examination Blue Prints:**

Internal assessment is done through quiz tests, presentations, assignments and project work. Two sets of question papers are asked from each faculty and out of these two, without the

knowledge of faculty, one question paper is chosen for the concerned examination. The components of evaluations alongwith their weightage followed by the University is given below

| | |
|---|---|
| Sessional Test | 20% |
| Internals | 10% |
| End term examination | 70% |

**LECTURE PLAN**

| | | | |
|---|---|---|---|
| **Institute / School Name :** | DARBHANGA COLLEGE OF ENGINEEERING | | |
| **Program Name** | B.Tech (EEE, 8th semester) | | |
| **Course Code** | 031828 | | |
| **Course Name** | Direct Energy Conversion | | |
| **Lecture / Tutorial (per week):** | 3/1 | **Course Credits** | 4 |
| **Course Coordinator Name** | Mr. Deepak Singh | | |

| **Topics** | **Lecture Number** |
|---|---|
| **System and Signal** | |
| MODULE 1 Introduction (4 LECTURES) | |
| Energy sources, Energy conversion chart, | **1-2** |
| Direct Energy Conversion (DEC) devices, General representation of DEC devices | **3-4** |
| MODULE 2 Thermoelectric Power Generation (7 LECTURES) | 5-11 |
| Introduction, Thermoelectric effects, Thermodynamic analysis of Thermoelectric generator, | **5-7** |
| Maximum thermal efficiency and maximum power output, Single stage and multistage generators, Thermoelectric materials, Applications. | **8-11** |
| MODULE 3: Fuel Cells (7 LECTURES) | 12-18 |
| Introduction, Principle of fuel-cell operation and different types of fuel-cells reactions, electrochemical thermo-dynamics, | 12-15 |
| Relation of cell potential to thermodynamic variables, Cell efficiency, Polarization losses, Types of fuel cells, Performance characteristics, Applications. | **15-18** |
| MODULE 4: Solar Cells (7 LECTURES) | 18-25 |
| Introduction, Basic theory of p-n junction photovoltaic | 18-21 |

| | |
|---|---|
| converters, Characteristics of solar radiation, Typical schematic representation of a solar cell and the idealized equivalent circuit, | |
| efficiency, Materials for photovoltaic conversion and cell fabrication, Silicon, Cadmium Sulphide and Gallium Arsenide cells, Application, System design methodology. | **21-25** |
| MODULE 5: MHD Generator (10 LECTURES) | 26-35 |
| Introduction, Gaseous conductors, Seeding, MHD equations, Operating range of an MHD duct, Different types of MHD generators, | 26-30 |
| Thermodynamic analysis of linear constant velocity MHD generator, Electrical power output and efficiency, Adiabatic efficiency, Introduction to liquid MHD generator. | **30-35** |
| MODULE 6: Fusion Power (5 LECTURES) | 36-40 |
| Principles of fusion power production, Advantages of fusion power | 36-38 |
| Problems in achieving controlled thermonuclear reactions, Plasma confinement, heating and diagnostics, Fusion devices. | **38-40** |
| MODULE 7: Wind Power (5 LECTURES) | **41-45** |
| Wind Power : Introduction to Wind Power Generation. | **41-45** |

# DARBHANGA COLLEGE OF ENGINEERING, DARBHANGA

**8th Sem. Branch:- Electrical & Electronics Engineering Batch (2016-20)**

## Subject :- Direct Energy Conversion

| Sl. No. | Name | Class Roll No. |
|---|---|---|
| 1. | Rajbala Kumari | 16-EE-01 |
| 2. | Sushmita Kumari | 16-EE-03 |
| 3. | Shweta Rani | 16-EE-04 |
| 4. | Nisha Raj | 16-EE-05 |
| 5. | Priyanka Kumari | 16-EE-07 |
| 6. | Rashmi Bharti | 16-EE-08 |
| 7. | Sonika Kumari | 16-EE-09 |
| 8. | Puja Prabhakar | 16-EE-11 |
| 9. | Devashish Dubey | 16-EE-12 |
| 10. | Alok Ranjan | 16-EE-13 |
| 11. | Hemant Kumar patel | 16-EE-14 |
| 12. | Kumar Satyam | 16-EE-15 |
| 13. | Pratik Kumar | 16-EE-17 |
| 14. | Prabhash Kumar Yadav | 16-EE-18 |
| 15. | Ranjesh Kumar | 16-EE-19 |
| 16. | Upendra Kumar | 16-EE-20 |
| 17. | Amit Kumar | 16-EE-21 |
| 18. | Wajahat Khalil | 16-EE-22 |
| 19. | Prakash Ranjan | 16-EE-24 |
| 20. | Rahul Kumar | 16-EE-26 |
| 21. | Ankit Ranjan | 16-EE-27 |
| 22. | Varinder Kumar | 16-EE-29 |
| 23. | Vikash Kumar Bharti | 16-EE-30 |
| 24. | Navneet Kumar | 16-EE-31 |
| 25. | Prem Raj | 16-EE-32 |

| | | |
|---|---|---|
| 26. | Juhi Kumari | 16-EE-33 |
| 27. | Appu Kumar | 16-EE-34 |
| 28. | Ashish Kumar | 16-EE-35 |
| 29. | Babloo Kumar | 16-EE-36 |
| 30. | Niraj Kumar Nirala | 16-EE-37 |
| 31. | Poonam Priya | 16-EE-38 |
| 32. | Kamal Nayan Jha | 16-EE-40 |
| 33. | Rajneesh Kumar | 16-EE-41 |
| 34. | Rohit Kumar | 16-EE-42 |
| 35. | Amrita Kumari | 16-EE-43 |
| 36. | Dimple Kumari | 16-EE-44 |
| 37. | Khushbu Kumari | 16-EE-45 |
| 38. | Alok Kumar | 16-EE-46 |
| 39 | Md. Ataur Rahman | 16-EE-47 |
| 40 | Shubhra Verma | 16-EE-48 |
| 41 | Khushboo Kumari | 16-EE-49 |
| 42 | Priti Kumari | 16-EE-50 |
| 43 | Md. Sharmajul Haque | 16-EE-51 |
| 44 | Saurav Kumar | 16-EE-52 |
| 45 | Anubhav Anand | 16-EE-53 |
| 46 | Shankar Suwan Kesri | 16-EE-54 |
| 47 | Tanuj Anand | 16-EE-55 |
| 48 | Ganesh Kumar | 16-EE-56 |
| 49 | Ashish Ranjan | 16-EE-57 |
| 50 | Shashi Kumar | 16-EE-58 |
| 51 | Vishnu Kumar | 16-EE-59 |
| 52 | Anku Rani | 16-EE-60 |
| 53 | Santosh Kumar Mahto | 16-EE-61 |
| 54 | Shubham Kumar | 16-EE-62 |
| 55 | Md. Seraj | 16-EE-63 |
| 56 | Amrendra Kishor | 16-EE-64 |

| | | |
|---|---|---|
| 57 | Amit Kumar Jha | 16-EE-65 |
| 58 | Rohit Kumar Yadav | 16-EE-66 |
| 59 | Rahul Kumar Sahni | 16-EE-67 |
| 60 | Saurabh Kumar | 16-EE-68 |
| 61 | Pankaj Kumar | 16-EE-69 |
| 62 | Pooja Roy | 16(LE)EE-01 |
| 63 | Surya Rai | 17(LE)EE-01 |
| 64 | Santosh Kumar | 17(LE)EE-02 |
| 65 | Lalit Kumar Ram | 17(LE)EE-03 |
| 66 | Deepak Kumar Prabhat | 17(LE)EE-04 |
| 67 | Sumit Kumar | 17(LE)EE-05 |
| 68 | Avinash Choudhary | 17(LE)EE-06 |
| 69 | Ranjeet Kumar Sah | 17(LE)EE-07 |
| 70 | Baby Kumari | 17(LE)EE-08 |
| 71 | Virendra Kumar Sah | 17(LE)EE-09 |
| 72 | Abhinav Raj | 17(LE)EE-10 |
| 73 | Ejaz Ahmad Ansari | 17(LE)EE-11 |

**DARBHANGA COLLEGE OF ENGINEERIG, DARBHANGA**

**MID SEMESTER EXAMINATION 2018- 19**

**ELECTRICAL ENGINEERING (8th SEM)**

**DIRECT ENERGY CONVERSION**

**(031828)**

**Time: 2 hours** **Maximum Marks: 20**

Attempt all questions.

1. Draw and explain the equivalent circuit of a solar photovoltaic cell? What are the advantages and disadvantages of the solar cell compare with conventional system?
2. Explain and draw the V-I and PV characteristics of solar cell and maximum power point tracking in solar PV?
3. Explain fill factor and efficiency? Calculate fill factor, maximum power and efficiency with following parameter
   $V_{oc}$ = 0.24V, $I_{sc}$ = -10A
   $V_m$ = 0.14V, $I_m$ = -6.5A
   Intensity = 100 W/$m^2$, Area = 4 $cm^2$.
4. Briefly explain elementary open cycle MHD and closed cycle MHD system along with diagram?
5. Calculate the open circuit voltage and maximum power output of MHD system with the following specification?
   Plate area = 0.4$m^2$, distance between plates = 0.8m, flux density = 2Wb/$m^2$, average gas velocity = 100m/s, conductivity of gas = 10 ohm/m.

**DARBHANGA COLLEGE OF ENGINEERING**

**Department of Electrical and Electronics Engineering Direct Energy Conversion**

## Assignment I

1. Write the mathematical form of I-V characteristics of solar cell?
2. What is the range of efficiency of solar cell?
3. What is the condition for generation of electron hole pair in the term of energy band?
4. What is the maximum power tracking in solar PV cell?
5. Give the classification of fuel cell?

**Department of Electrical and Electronics Engineering**

**Direct Energy Conversion**

## Assignment II

1. What are the advantages and disadvantages of fusion power?
2. Explain the principle of fusion power generation?
3. Discuss different types of MHD generating system?
4. Explain briefly:
    a) Solar power plant
    b) Wind energy plant
    c) Tidal power plant
    d) Geothermal power plant

**Department of Electrical and Electronics Engineering**

**Direct Energy Conversion**

## Assignment III

1. Describe the energy conversion chart with various source of energy?
2. What are the various types of fuel cell and state the principle of operation?
3. Show the basic construction and working of pn junction of photovoltaic converter?
4. Write the short notes on
    a) Material for MHD generator
    b) Seeding

**Department of Electrical and Electronics Engineering**

**Direct Energy Conversion**

**Assignment IV**

1. How is a solar cell fabricated? What are the factors which limit the solar cell efficiency?
2. Explain the thermodynamics of fuel cell reaction and give the applications.

Code : 031828

**B.Tech. 8th Semester Exam., 2017**

**Direct Energy Conversion**

*Time : 3 hours* *Full Marks : 70*

***Instructions :***

*(i) The marks are indicated in the right-hand margin.*

*(ii) There are **Nine** questions in this paper.*

*(iii) Attempt **Five** questions in all.*

*(iv) Questions No. 1 is compulsory.*

1. 14

(a) Write the mathematical form of I-V characteristic of solar cell.

(b) Write the classification of solar cell on the basis of thickness of active material.

(c) What is the condition for generation of electron hole pair in terms of band gap and energy in photon.

(d) What is the range of efficiency of solar cell (single crystal) ?

(e) Write the classification of fuel cell based on chemical nature.

(f) Power generation through μHD generation based on faraday effect.

state true or false

(g) Induction generator can be used for converting wind power of electric power.

state true or false

(h) In full cell chemical energy in directly converted to electric enuars.

write true or false

(i) Thermo-electric generation produce direct current.

write true or false

2. (a) Write the advantages and disadvantages of solar cell compared to conventional System. 7

(b) Draw and explain equivalent circuit of a solar cell. 7

3. (a) What is maximum power point traking in solar PV system? What are the different strategies for maximum power point traking? 14

4. (a) Give the classification of fuel cell. 7

(b) Draw and explain the VI characteristic of fuel cell. 7

5. (a) Discuss different types of μHD generating system.

(b) What are the advantages and disadvantages of μHD generation? 7+7



6. (a) Explain thermo-electric power conversion. 7

(b) Show maximum power output of thermo-electric generation $P_{max} = \frac{4\alpha^2 4T^2}{4Kg}$

7. (a) Explain the principle of fusion power generation. 7

(b) What are the advantages and disadvantages of fusion power? 7

8. (a) Discuss the basic principle of μHD generation. 7

(b) Derive the express for maximum power output of μHD generation. 7

9. Write short notes : 7×2

(a) Wind energy conversion system

(b) Solid oxide fuel cell

***

# Code : 031828

## B.Tech 8th Semester Exam., 2019

### DIRECT ENERGY CONVERSION

*Time* : 3 hours *Full Marks* : 70

*Instructions* :

*(i) The marks are indicated in the right-hand margin.*

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

**1.** Choose the correct answer of the following (any *seven*) : 2×7=14

*(a)* Which of the following is a conventional source of energy?

*(i)* Sun

*(ii)* Wind

*(iii)* Fossil fuel

*(iv)* Fuel cell

*(b)* To increase current, PV module can be connected in

*(i)* series

*(ii)* parallel

*(iii)* Both of the above

*(iv)* None of the above







*(c)* The efficiency of a solar cell

*(i)* increases with increase in temperature

*(ii)* decreases with increase in temperature

*(iii)* unaffected with increase in temperature

*(iv)* first increases and then decreases with increase in temperature

*(d)* A fuel cell in order to produce electricity burns

*(i)* helium

*(ii)* nitrogen

*(iii)* hydrogen

*(iv)* None of the above

*(e)* Local winds are caused by

*(i)* differential heating of land and water

*(ii)* differential heating of plains and mountain

*(iii)* Any of the above

*(iv)* None of the above

(f) In which of the following power plants the availability of power is least reliable?

(i) Solar power plant

(ii) Wind energy plant

(iii) Tidal power plant

(iv) Geothermal power plant

(g) What is used to turn wind energy into electrical energy?

(i) Turbine

(ii) Generator

(iii) Yaw motor

(iv) Blade

(h) Which is a direct band gap material?

(i) Copper indium gallium selenide

(ii) Copper selenide

(iii) Copper gallium telluride

(iv) Copper indium gallium diselenide

(i) Energy efficiency is defined as

(i) energy that escapes in an unusable form

(ii) energy in bonds formed subtracted from energy in bonds broken



( Turn Over )







(iii) the content of energy in a fossil fuel

(iv) the amount of energy extracted from a system divided by the total energy provided into the system

(j) During inter-conversion of energy from one form to other form, the total energy at any time

(i) remains constant

(ii) remains zero

(iii) increases

(iv) decreases

2. (a) Describe the energy conversion chart with various sources of energy. 6

(b) Illustrate the thermoelectric effects with neat sketch. 8



3. (a) What are the various types of fuel cell? Extend the principle of operation of any one. 7

(b) Demonstrate the working principle of MHD open-cycle system. 7



( Continued )

**4.** *(a)* List the various thermoelectric materials. 4

*(b)* Certain elements *A* and *B* have the following properties in the temperature range of interest :

$\alpha_{p,n} = 0 \cdot 003$ V/K

$K_p, K_n = 0 \cdot 04$ W/K

$R_p R_n = 0 \cdot 025$ ohm

The elements operate between junction temperatures of 1250 K and 750 K. Determine—

*(i)* the maximum output and the efficiency at maximum output;

*(ii)* the input power and terminal voltage at no load;

*(iii)* the input power and current under short-circuit condition. 10

**5.** Show the basic construction and working of a *p-n* junction photovoltaic converter. Also select the materials used for construction. 14

**6.** A thermoelectric generator is to be used as a topping unit for a steam power plant. The thermoelectric generator producing 100 kW at 115 V operates between an output









temperature of 1500 K and exit temperature of 1000 K. A steam turbine and generator unit operating at an input temperature of 1000 K and ambient temperature of 350 K has a thermal efficiency of 30% and a generator efficiency of 92%. The properties of thermoelements are given below :

$\alpha_{p,n}$ at 1250 K $= 0 \cdot 0012$ V / K

$k_p = 0 \cdot 20$ W / cm-K

$k_n = 0 \cdot 030$ W / cm-K

$\rho_p = 0 \cdot 010$ ohm-cm

$\rho_n = 0 \cdot 012$ ohm-cm

The current density in the thermoelements is limited to 20 A/cm$^2$ and the thermoelectric generator is aimed to operate at maximum thermal efficiency. Calculate—

*(a)* the thermal efficiency of the thermoelectric generator;

*(b)* the number of thermal couples in series;

*(c)* the sizes of thermal elements;

*(d)* the open-circuit voltage;

*(e)* the heat input and heat rejected from the thermoelectric generator at both full-load and no-load conditions;

*(f)* the overall efficiency of the combined thermoelectric steam power plant. 14

7. Elaborate the construction and working principle of wind power generation system. 14

8. *(a)* An MHD generator has the following parameters :

| | |
|---|---|
| Plate area | = 0·20 $m^2$ |
| Distance between plates | = 0·4 $m^2$ |
| Flux density | = 2 $Wb/m^2$ |
| Average gas velocity | = 1000 m/s |
| Conductivity of the gas | = 10 mho/m |

Calculate the open-circuit voltage and maximum power output. 6

*(b)* Write short notes on : 4+4

*(i)* Materials for MHD generator

*(ii)* Seeding

9. *(a)* Identify the various problems in achieving the controlled thermonuclear reactions. 8

*(b)* Develop the various solar radiation angles considering a flat surface on ground facing south. 6

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# Code : 031728

## B.Tech 7th Semester Exam., 2019

## DIRECT ENERGY CONVERSION

*Time* : 3 hours *Full Marks* : 70

*Instructions* :

*(i) The marks are indicated in the right-hand margin.*

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. 1 is compulsory.*

**1.** Choose the correct answer (any *seven*) : 2×7=14

(a) A photovoltaic cell converts

*(i)* heat energy into mechanical energy

*(ii)* chemical energy into electrical energy

*(iii)* solar energy into electrical energy

*(iv)* electrical energy into chemical energy









(b) Which of the following is a non-conventional type of power generation without prime movers?

*(i)* Hydropower

*(ii)* Thermal

*(iii)* Nuclear

*(iv)* Thermoelectric

(c) Fuel cell performance is not limited by

*(i)* first law of thermodynamics

*(ii)* second law of thermodynamics

*(iii)* third law of thermodynamics

*(iv)* All three laws are applicable

(d) For which of the following devices negative charge carriers flow from anode to cathode in the external circuit?

*(i)* MHD generator

*(ii)* Thermionic generator

*(iii)* Thermoelectric generator

*(iv)* Fuel cell

(e) The major disadvantage with solar cells for power generation is

*(i)* lack of availability

*(ii)* large area requirement

*(iii)* variable power

*(iv)* high cost

(f) Winds, caused by greater solar heating of the earth's surface near the equator than near the northern or southern poles, are known as

(i) local winds

(ii) equatorial winds

(iii) planetary winds

(iv) trade winds

(g) Which direct energy converting systems is not limited by Carnot efficiency?

(i) Thermoelectric

(ii) Thermionic

(iii) MHD

(iv) Fuel cells

(h) A nuclear waste is generated in

(i) chemical reactions

(ii) nuclear fission

(iii) nuclear fusion

(iv) None of the above

(i) The methods of plasma heating are

(i) ohmic heating

(ii) neutral beam injection

(iii) compression heating

(iv) All of the above









(j) Thermoelectric effects are

(i) Seebeck, Thomson, Rutherford effects

(ii) Thomson, Peltier, Curie effects

(iii) Seebeck, Peltier, Thomson effects

(iv) Peltier, Curie, Seebeck effects

2. (a) What are the various energy sources? Discuss the energy conversion chart. 7

(b) Differentiate between direct energy conversion processes and other energy conversion processes for power generation. 7

3. Design a thermoelectric generator to operate from a heat source of 1000 K and to reject heat 600 K. The required output is 50 W at 6 V. The properties of the materials to be used are

$\alpha_{p,n} = 0 \cdot 001$ V/K, $k_p = 0 \cdot 03$ W/cm-K,

$k_n = 0 \cdot 02$ W/cm-K, $\rho_p = 0 \cdot 005$ ohm-cm,

$\rho_n = 0 \cdot 006$ ohm-cm

Assume the thermoelectric elements to be 1 cm in length. 14

What do you understand by 'figure of merit'? When does its value become the maximum? What is the optimum resistance ratio for *(a)* maximum power and *(b)* maximum efficiency? Explain the cascade multistage operation of thermoelectric generators. 14

5. *(a)* What are the three types of fuel-cell reactions? Give the thermo-oxygen, carbon-oxygen and methane-oxygen fuel-cell reactions. 7

*(b)* Explain the thermodynamics of fuel-cell reactions and give the applications of fuel cell. 7

6. *(a)* How is a solar cell fabricated? What are the factors which limit the solar cell efficiency? 7

*(b)* A constant velocity MHD generator operates at pressure ratio of 3. The gas used has polytropic index $\gamma = 1 \cdot 35$. Find the adiabatic efficiency of this device as a function of the loading factor and plot this. 7

Describe the working principle of magneto-hydrodynamic power generation power plant. Also describe either open cycle MHD steam power plant or closed cycle MHD steam power plant. 14









8. *(a)* What is the principle of fusion power? Discuss its various advantages and disadvantages. 7

*(b)* What are the various problems associated with controlled thermo-nuclear reactions? How are these problems resolved? 7

9. *(a)* What are the various wind turbines? Explain wind turbine power plant with a schematic diagram. 7

*(b)* Derive the formula of coefficient of performance ($C_p$) of wind energy conversion system. What is the maximum value of $C_p$? 7

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# DARBHANGA COLLEGE OF ENGINEERIG, DARBHANGA

## ELECTRICAL ENGINEERING (8th SEM)

## DIRECT ENERGY CONVERSION

### UNIT I

### DIRECT ENERGY CONVERSION:

1. Why non-conventional energy sources have become important?
2. What is conventional and non-conventional energy?
3. Give examples of various bio-fuels?
4. What are tidal energy and its application?
5. Relate civilization to energy and explain?
6. Give various resources of non-conventional energy generation?
7. How geothermal energy is harnessed?
8. In what way wind energy can be utilized?
9. What is solar-pond? Discuss its application?
10. How fuel cell can be used for power generation
11. Explain how geothermal energy is used to generate electricity?
12. Discuss the advantage and limitation of tidal power gestation?
13. What is difference between Renewable and Non-renewable energy resources? Give examples?
14. What do you mean by solar collector
15. Name the various direct energy conversion systems.
16. What are the various sources of geothermal energy?
17. What is tidal energy?
18. What are the main sources of bio-mass?
19. List various Non-conventional energy resources. Give their availability, relative merits and demerits.
20. What are the main strategies you think for meeting the future energy requirements?
21. Distinguish between conventional and non-conventional energy sources?

## UNIT II

## THERMOELECTRIC POWER GENERATION:

1. What is thermoelectric effect?
2. Explain Seedback and Peltier effect?
3. Which are the thermoelectric materials? Mention its application?
4. Explain the working principle of thermionic power conversion with the main advantages and disadvantages?
5. Explain the principles of thermo-electric generator?
6. Describe briefly thermal electric power?
7. Explain the cascade multistage operation of thermoelectric generators?
8. What is direct band gap energy?
9. Illustrate the thermoelectric effect with neat sketch?
10. What are the thermoelectric materials?
11. Explain the thermal efficiency of thermoelectric generator?
12. Derive the overall efficiency of the combined thermoelectric steam power plant?
13. What are the heat input and heat output rejected from the thermoelectric generator?
14. What is open circuit voltage?
15. What is the condition for generation of electron hole pair in term of band gap and energy in photon?
16. Discuss performance parameter of a thermoelectric module?
17. Discuss the p and n type unit thermocouple for a thermoelectric generator?
18. What are the limitations of thermoelectric generator?
19. Explain the types of material used in thermoelectric generator?
20. Write short notes on Thomson effect?

## UNIT III

## FUEL CELL:

1. Write a note on ideal and real efficiencies of fuel cell?
2. Discuss the relation between activation energy and reaction rate?
3. What are the major requirements for a candidate fuel cell electrolyte?
4. Discuss the various methods to improve the kinetic performance of a fuel cell?
5. List the important qualities required for an effective fuel cell catalyst material?
6. List two major advantages and two major disadvantages of fuel cells compared to other power conversion devices?
7. Explain the four major steps in the generation of electricity within a fuel cell?
8. Write a note on stack clamping?
9. List the technologies for hydrogen storage?
10. Write the cell reaction of alkaline fuel cell?
11. Explain advantages and disadvantages of fuel cell?
12. Explain basic reaction in fuel cell and enthalpy formation and enthalpy change of reacting system?
13. Explain Efficiency and power due to entropy change and internal ohmic heating?
14. Explain Acid and Molten carbonate fuel cell?
15. Explain the difference between ordinary batteries and fuel cell?
16. Discuss the application and economic aspect of fuel cell?
17. How fuel cell can be used for power generation?
18. What are the different types of fuel cells?
19. What are limitations of fuel cell?
20. What is the operation of hydrogen fuel cell?
21. Discuss different type of polarization that occurs in fuel cell?
22. Explain the thermodynamics of fuel cell reaction and give their applications?

## UNIT IV

## SOLAR CELL:

1. Explain photo electricity with the help of neat sketch?
2. Mention major advantages of solar photovoltaic cells over conventional power system?
3. Write note on solar cell classification?
4. Explain solar cell applications?
5. Explain solar cell, module, panel and array constructions?
6. Explain with sketches maximum power point tracker (MPPT) using buck-boost converter?
7. A PV system feeds a DC motor to produce 1hp power at the shaft. The motor efficiency is 85%. Each module has 36 multi crystalline silicon solar cells arranged in 9X4 matrix. The cell size is 125X125mm and cell efficiency is 12%. Calculate the number of modules required in the array. Assuming global radiation incident normally to the panel as $1kW/m^2$?
8. Discuss various techniques available to utilize solar energy?
9. What are the applications of solar energy?
10. What are various types of solar collector? Explain the design procedure?
11. Discuss the performance analysis of cylindrical and parabolic solar collector?
12. What is solar constant?
13. What do you understand by figure of merit?
14. How is solar cell fabricated?
15. Show the basic principal of p-n junction photovoltaic converter?
16. Develop various solar radiation angles considering the flat surface on ground facing south?
17. What are the factors which limit the solar efficiency?
18. What is the range of efficiency of solar cell?
19. Write the mathematical form of I-V characteristics of solar cell?
20. Write short notes on:
    (a) Magnetic Hydrodynamic (MHD) Generator.
    (b) Tidal energy.
    (c) Solar energy storage systems.

## UNIT V

## MHD GENERATOR:

1. Explain the basic principles of a magneto hydrodynamic power (MHD) conversion system?
2. Draw suitable sketch and explain open cycle MHD power generating system?
3. Explain with suitable sketch and explain closed cycle MHD power generating system?
4. Discuss the environmental aspect of MHD?
5. What are the main types of MHD (Magnetic Hydrodynamic) systems?
6. Write short note on seeding?
7. Explain the material for MHD generator?
8. What is the open circuit voltage for MHD generator?
9. Discuss maximum power of MHD generator?
10. Explain the types of power generation through MHD generation?
11. What are the advantage and disadvantages of MHD generation?
12. Derive the working of the MHD?
13. What is the MHD cycle?
14. What is the speed recovery system?
15. Demonstrate the working principle of MHD closed cycle system?
16. Define the pre-heater and combustor?
17. Explain the hybrid MHD generator?
18. Define compressor?
19. Derive the maximum power of MHD generator?
20. Demonstrate the working principle of MHD open cycle system?

## UNIT VI

## FUSION POWER AND WIND POWER:

1. Explain energy release during nuclear fusion reaction?
2. What is the principle of fusion power?
3. Discuss the various advantages and disadvantages of fusion power?
4. What are problem associated with controlled thermo-nuclear reaction? How these problem resolve?
5. List the various components of Wind turbines?
6. What is wind energy? Discuss the factor affecting the site selection for wind mills?
7. Explain various basic components of wind energy conversion system?
8. What is the wind mill? Mention dynamic forces acting on wind mill blades?
9. What is total power density in wind stream?
10. Explain the torque and axial thrust on horizontal shaft blade turbine?
11. Derive the formula of coefficient of performance $C_p$ of wind energy conversion?
12. What are the various wind turbines?
13. Explain the wind turbine power plant with a systematic diagram?
14. What are the different causes of local Winds?
15. What are the factors determine the output from a wind energy converter
16. Give the expression for available wind power?
17. Draw the curve that shows the combined effects of wind Speed and Rotor diameter on wind power generation?
18. Define Power Co-efficient?
19. Write the general Energy Equation for Steady State Flow?
20. What are the different types of forces acting on propeller type wind turbine?
21. What are the mechanisms for producing forces from wind?