- Groover, M. P., (2005) Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 2nd edition, John Wiley & Sons.
- Stauber, R., Vollrath, L. (2007) Plastics in Automotive Engineering: Exterior Applications, Hanser publications.
- Marur, S., (2011) Plastics Application Technology for Safe and Lightweight Automobiles.

SUGGESTIVE READINGS

- Callister, W. D., (2005) Materials Science and Engineering an Introduction, 6th edition, John Wiley & Sons.
- Yamagata, H., (2005) The Science and Technology of Materials in Automotive Engines, Yamaha Motor Co. Ltd., Japan Woodhead Publishing Limited.
- Davies, G., (2003) Materials for Automobile Bodies, Butterworth-Heinemann Publications.
- Koronis, G. Silva, A., (2018) Green Composites for Automotive Applications, Woodhead Publishing Series in Composites Science and Engineering.
- Sehanobish, K., (2009)"Engineering Plastics and Plastic composites in Automotive Applications", SAE internationals, Warrendale.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-13)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
POLYMERS IN ENERGY APPLICATION	4	2	0	2	Class 12th with Physics, Chemistry	---

Learning objectives

The Learning Objectives of this course are to:

- Make students familiar with use of advanced polymers for energy applications
- Learn about the manufacturing of fuel cells

- Understand polymer properties related to energy components

Learning outcomes

After studying this paper, students will be able to

- Select the polymers for energy applications
- Explain working process of lithium ion batteries and fuel cell

SYLLABUS OF DSE-13

THEORY COMPONENT-

UNIT 1: (6 Hours)

INTRODUCTION

Importance and need of energy storage, modes of energy transmission, batteries, thermal, mechanical storage, hydrogen, pumped hydropower, flywheels, role of polymer in energy storage applications. environmental and sustainability issues.

UNIT 2: (8 Hours)

ENERGY STORAGE DEVICES BASED ON POLYMERS

Introduction, principal, methodology & working: photovoltaics, supercapacitors, lithium-ion batteries: PVAc based polymer blend electrolytes for lithium batteries, preparation of solid polymer electrolytes based batteries, perovskite-type composite polymer electrolytes, PPO-type composite polymer electrolytes, sulfide-type polymer electrolytes, solid polymer electrolytes with ionic liquid, solid polymer electrolytes with cellulose.

UNIT 3: (8 Hours)

FUEL CELLS

Hydrogen generation & storage, fuel cells, principles and nanomaterials design for; proton exchange membrane fuel cells (PEMFC), sulfonated poly (ether-ether ketone)s, sulfonated poly(aryl ether) for PEMFC and direct methanol fuel cell (DMFCs). Polymer composite membrane role (cation/anion/proton-exchange membranes) in bio-electrochemical systems – construction and performance of MFCs.

UNIT 3: (8 Hours)

POLYMER NANOCOMPOSITES FOR RENEWABLE ENERGY STORAGE SYSTEMS

Solar cells: Types, functioning, mechanism, materials for solar cell and structure design, Concept of solar cells with organic quantum dots, Quantum dots (polymer multiple & molecular multiple quantum dots), polymer-inorganic hybrid solar cells, hybrid conjugated polymer-inorganic semiconductor composites, semiconducting polymer-based bulk heterojunction solar cells, current trends and future status.

PRACTICAL COMPONENT (60 Hours)

- To prepare methanol fuel cell.
- To design low, medium and high-temperature fuel cell.
- Preparation of proton exchange by membrane fuel cell.
- Preparation of hydrogen fuel cell.
- To prepare quantum dots grown by molecular layer deposition for photovoltaics.
- Synthesis of polymer multiple quantum dots.
- To test the efficiency of solar cell.
- Demonstrate the working principle of solar cell.
- To prepare PVAc based polymer blend electrolytes.
- To test the energy storage of Lithium batteries.

ESSENTIAL/RECOMMENDED READINGS

- Deborah, D.L., Chung, (2002) “Composite Materials”, Springer.
- Sun, S. S., Sariciftci, N. S., (2005) “Organic Photovoltaics”, CRC press-Taylor & Francis.
- Mohammad, F., (2007) “Specialty Polymers: Materials and Applications”, I. K. International Pvt Ltd.
- Chanda, M. Roy, S. K., (2008) “Industrial Polymers, Specialty Polymers“, and Their Applications, CRC Press.
- Ram K. Gupta, R. K., (2022) “Conducting Polymers for Advanced Energy Applications”, CRC Press.
- Thangadurai, T. D., Nandhakumar, M., Thomas, S., Nzihou, A., (2022) “Polymer Nanocomposites for Energy Applications”, Wiley.

SUGGESTIVE READINGS

- Malaika, S. Al, Wilkie, C. A., Golovoy, A., (2001) “Specialty Polymer Additives”, Wiley.
- Dyson, R. W., (1982) “Speciality polymers”, Chapman and Hall publications.

- Ise, N., Tabushi, I., (1983) "An Introduction to Speciality Polymers", CUP Archive.
- Inamuddin, Ahamed M. I., Boddula, R., Altalhi, T., (2022) "Polymers in Energy Conversion and Storage".
- Kroschwitz, J. I. (2003) "Encyclopedia of polymer science and technology", John Wiley.
- Mark, H. F. (2013). "Encyclopedia of polymer science and technology", John Wiley & Sons.

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DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE-14)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
3D PRINTING OF POLYMERS	4	3	0	1	Class 12th with Physics, Chemistry	---

Learning objectives

- Impart students to the fundamentals of various 3D Printing techniques for application to various industrial needs.
- Students will be able to convert part files into STL format and will understand the method of manufacturing of liquid based, powder based and solid based techniques.

Learning outcomes

The Learning Objectives of this course are as follows:

After studying this paper, students will be able to

- Use software tools for 3D printing
- Prepare 3D printed modules
- Construct products using LOM and FDM technologies

SYLLABUS OF DSE-14

THEORY COMPONENT-