

**ACADEMIC AFFAIRS OFFICE  
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

No. Acd./ 132 /IAPC-101

Dated: April 19, 2021

**Head, Department of Mechanical & Industrial Engineering**

The IAPC in its 101<sup>st</sup> meeting held on 19/21.03.2021 vide Item No. 101.2.4 considered and approved the proposal of Department of Mechanical Engg. to introduce new Open Elective Course i.e., IMI-301: Microwave Materials Processing: Theory and Practice w.e.f. the Academic Year 2021-2022 with minor modifications.

The modified syllabus is attached as **Appendix-A**.

*Reeti*

**Assistant Registrar (Curriculum)**

**Encl:** as above

**Copy to (through e mail):-**

1. All faculty
2. All Heads of Departments/Centres
3. Dean, Academic Affairs
4. Associate Dean of Academic Affairs (Curriculum)
5. Channel I/ Academic webpage of iitr.ac.in/ acad portal

## INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

**NAME OF DEPARTMENT/CENTRE:** Department of Mechanical & Industrial Engineering

**1. Subject Code:** IMI-301                      **Course Title:** Microwave Materials Processing: Theory and Practice

**2. Contact Hours:**                      **L:** 3                      **T:** 0                      **P:** 0

**3. Examination Duration (Hrs.):**                      **Theory:** 3                      **Practical:** 0

**4. Relative Weightage:**    **CWS:** 20-35                      **PRS:** 0                      **MTE:** 20-30                      **ETE:** 40-50                      **PRE:** 0

**5. Credits:** 3                      **6. Semester:** Both                      **7. Subject Area:** OEC

**8. Pre-requisite:** Students should have basic knowledge in materials and their processing

**9. Objectives:**

- To familiarize the students with the various aspects of microwaves and their potential in material processing.
- To enable the students to understand various applications of microwave energy in materials processing.
- To educate the students about the phenomena of microwave energy-material interactions.

### 10. Details of the Course

S.No.	Contents	Contact hours
1.	Introduction: History of MW applications and processing; microwave system and its various components, fundamentals of microwave materials processing: definitions, advantages, temperature measurements, hybrid heating, susceptors, etc.; microwave safety issues. Introduction of waveguide in microwave.	5
2.	Microwave-Matter Interactions and Mechanisms: Various mechanisms (heating due to magnetic effect, dipolar movement, eddy-current, hysteresis loss etc.) to explain MW-matter interactions, anisothermal heating and measurement of dielectric property.	5
3.	Microwave E and H Fields Separation: Difference between multi and single mode microwave systems and how to separate E and H fields; heating profile of ceramics, metals and composites in separate E and H fields, decrystallization of various special materials in H-field at 2.45 GHz.	6
4.	Applications of Microwave Energy: Ceramics: Traditional Ceramics: alumina, zirconia, hydroxyapatite, transparent ceramics, electroceramics and advanced ceramics Composites: Ceramic-metal: Sintering of WC/Co based cutting tools, processing of ceramic-metal composites, processing high temperature ceramic eutectics Ceramic-polymer and Metal-polymer: Microwave processing of these composites and Microwave curing of thermoplastic, composite based on natural/synthetic reinforcement. Metals: General introduction, metallic powders sintering including Fe, Cu, steel, Ti, alloys, etc., melting and steel making.	12
5.	Applications of Microwave Energy in Different Processes: Microwave brazing and joining of bulk metals, microwave cladding, microwave drilling of glass and metal and microwave casting of bulk metals	10

6.	Microwave Multi-Energy Processing: Materials processing in microwave + hydrothermal, microwave + plasma, microwave + laser and how they impact on the materials processing	4
<b>Total</b>		<b>42</b>

## 11. List of Demonstration Experiments

S.No.	Contents	Contact hours
1.	To study the role of susceptor in microwave processing	1
2.	Microwave sintering of materials (say, ceramics+metal)	1
3.	Microwave cladding of materials	1
4.	Microwave joining of metallic materials	1
5.	Microwave processing of polymers and composites	1

## 12. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Metaxas, AC and Meredith Roger J. "Industrial microwave heating", Peter Peregrinus Ltd., London, ISBN: 0 906048 89 3	1983
2.	Clark, David E. and Sutton WH. "Microwave processing of materials", Annual Review of Materials Science.	1996
3.	Clark, David E. and Sutton WH. "Microwave solutions for ceramic engineers", American Ceramic Society, ISBN: 1-57498-224-9	2005
4.	Gupta, Manoj, and Eugene Wong Wai Leong. "Microwaves and metals", John Wiley & Sons, ISBN:9780470822722	2008
5.	Binner, Jon, Paul Hogg, and John Murphy. "Advanced materials source book", Elsevier, ISBN: 185617 238 4	2013

## 13. Suggested References:

1.	Dinesh Agrawal, "Microwave processing of ceramics", Solid State and Materials Science, Vol. 3 (480-485)	1998
2.	Clark, David E., Diane C. Folz, and Jon K. West. "Processing materials with microwave energy" Materials Science and Engineering: A, Vol. 287(153-158)	2000
3.	Mishra, Radha Raman and Apurbba Kumar Sharma. "Microwave–material interaction phenomena: heating mechanisms, challenges and opportunities in material processing." Composites Part A: Applied Science and Manufacturing, Vol. 81(78-97)	2016