ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

No. Acd./2040/IAPC-78 Dated: January 21, 2020

Head, Department of Metallurgical & Materials Engineering
(through e-mail)

The IAPC in its 78th meeting held on 31.12.2019 vide **Item No. 78.2.2** considered and accepted the proposal to introduce a PEC MTN-559: Defects in Crystalline Materials. The approved course is attached as **Appendix-A**.

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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Metallurgical and Materials Engineering

1. **Subject Code**: MTN-559 **Course Title**: Defects in Crystalline Materials

2. **Contact Hours**: **L:** 3 **T:** 1 **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:** 4 **6. Semester:** Autumn

7. **Pre-requisite:** Nil **8. Subject Area:** PEC

9. **Objective:** To develop an understanding of point defects and dislocations in crystalline materials

10. **Details of the Course**:

Sl. No.	Contents	Contact Hours
1	**Review of basic concepts**: Brief review of crystallography and structure of materials, Types of bonds in solids, Extent of ionicity and covalency, brief introduction to elasticity and concept of strain energy, brief review of laws of thermodynamics including Gibbs-Duhem equation and phase rule, review of solution thermodynamics.	5
2	**Classification of defects**: Importance of defects in microstructures, classification of defects.	2
3	**Point defects in metals**: Thermodynamics of point defects, Equilibrium concentration of vacancies, Preferred location of self-interstitials in different lattices and heir equilibrium concentrations, Point defect complexes and interactions between point defects.	4
4	**Point defects in ionic and intermetallic compounds** : Vacancies and anti-sites on sublattices, Kroger-Vink notation, Schottky and Frenkel defects, Brouwer diagram, Doping to alter defect chemistry.	4
3	**Introduction to Dislocations** : Historical perspective, Theoretical shear strength and critically resolved shear stress, Geometrical definitions, Edge and Screw components, Burgers circuit, Perfect and Partial dislocations, Dislocation junctions, Dislocation motion: Glide and climb, Slip plane, Cross-slip of screw dislocations, Dislocation mobility and the Orowan equation.	6
4.	**Continuum model of dislocations:** Volterra model, Stress fields around straight dislocations, Singularity at dislocation core, Strain energy of volterra dislocations and its consequences, Forces on dislocations: Peach-Keohler equations, Elastic interactions between dislocations, Polygonization and Static recovery.	6
5.	**Atomistic model of dislocations:** Peierls-Nabarro (PN) model of dislocations, key differences from the Volterra model, Peierls stress for dislocation motion, consequences of the PN model, dislocations in FCC, BCC and HCP crystals.	8
6	**Strengthening mechanisms in crystals**: Dislocation interactions and formation of Jogs and Kinks, Short and long range obstacles to dislocation	7

	glide, Stages in material deformation, Dynamic recovery, Dislocations-defects interactions and solute atmospheres, Dislocation sources.	
Total		**42**

11. Suggested Books:

Sl.No.	Authors/Name of Books/ Publisher	Year of Publications/ Reprint
1	Cai W., and Nix W. D., Imperfections in crystalline solids, Cambridge university Press	2016
2	Hull D., and Bacon D. J., Introduction to dislocations, Butterworth-Heinemann	2011
3	Dieter G.E., Mechanical Metallurgy, McGraw-Hill Education	2017
4	Weertman, J., and Weertman J.R., Elementary dislocation theory, Oxford University Press	1992
5	Anderson P.W., Hirth, J. P., and Lothe J., Theory of dislocations, Cambridge University Press	2017