Course Code: MMTC-419
Title of the Course: Industrial Microbiology
Number of Credits: 03

Prerequisites for the course:	Basic knowledge about the types of microbes and their products of industrial relevance.	
Objective:	Understanding of concepts in the fermentation processes employed in the industries to produce the products using marine microorganisms.	
Content:	**Module I** Industrial strains, Fermentation media, Asepsis and sterilisation, growth kinetics - Bioreactor design and operation: classification of reactors; designing parameters for reactors (stirred tank reactor, airlift reactor, plug flow reactor) - rheology of fermentation broth - gas-liquid mass transfer, heat transfer, scale up - Solid substrate fermentation (SSF): Principles and application with examples (penicillin, amylase) - Immobilized enzymes and cell systems.	15 hrs
	Module II Fermentation monitor and control: speed, temperature, gas, pH, Dissolved oxygen, foam, redox, air flow, weight, pressure, biomass - On-line and off-line analysis - Layout and components of fermentation process for extracellular and intracellular microbial products - Recovery of biomass (cells and solid particles), cell disruption for recovery of intracellular products, primary isolation (extraction, sorption), precipitation, industrial processes for chromatography and fixed bed adsorption, membrane separations - drying, crystallisation, whole broth processing (Penicillin production) - Formulation, packaging - QC/QA; IPR – Patents, Trademark, Copyright, Process of Application, examples.	15 hrs
	Module III Industrially important marine microorganisms - Microbiological techniques in marine food industry, canning, freezing, drying - Industrial production and application – enzymes (Proteases, Lipases, amylase, pectinase), carotenoids, EPS, bioplastics, biopolymers – xanthan, pigments, Antibiotics-erythromycin, steroids, SCP, biofuels – Entrepreneurship.	15 hrs

Pedagogy:	Lectures/ tutorials/ assignments/ self-study	
References/ Readings:	1. Demain, A.L., Davies, J.E. and Atlas, R.M. (2010). Manual of industrial microbiology and biotechnology. ASM Press, Washington, U.S. 2. Flickinger, M.C. and Drew S.W. (2002). The Encyclopedia of bioprocess technology: Fermentation, biocatalysis and bioseparation. Volumes 1 – 5. John Wiley Publisher, New Jersey. 3. Stanbury, P.F., Whitaker, A. and Hall S.J. (2016). Principles of fermentation technology. 3rd Edition. Butterworth-Heinemann Publishers, Oxford, U.K. 4. Arad, S.M. (1999). Polysaccharides from red microalgae. In, Chemicals from microalgae, Cohen, Z. (Ed.). Taylor and Francis, London. Pp. 282-292. 5. Borowitzka M.A. (1995). Microalgae as sources of pharmaceuticals and other biologically active compounds. Journal of Applied Phycology 7, 3-15. 6. Kopecky J., Schoefs B., Loest K., Stys D. and Pulz O. (2000). Microalgae as a source for secondary carotenoid production: a screening study. Archiv für Hydrobiologie Supplement 133, 153-168. 7. Melis A. and Happe T. (2001). Hydrogen production. Green algae as a source of energy. Plant Physiology 127, 740-748.	
Learning Outcomes:	1. Study the industrial processes for production of metabolites from marine microorganisms.	