Name of the Programme: M. Sc (Botany)
Course Code: BOT-607
Title of the Course: Applied Phycology: Utilization and Management
Number of Credits: 4
Effective from AY: 2022-23

Prerequisites for the course:	Basic knowledge of algae.	
Objective(s):	To impart knowledge on the commercial applications of Algae and their use in environmental management.	
Content:	1. **Mariculture:** Scientific basis and Techniques of Mariculture: *Eucheuma*, *Porphyra,* and *Laminaria* technique. Rafts used in Mariculture.	**5 hours**
	2. **Seaweed cultivation in India:** Seaweed resources and their distribution in India, Promotion of seaweeds in India, Seaweed cultivation and value chain in India. Seedling production of *Gracilaria* and *Ulva*.	**2 hours**
	3. **Food and food products from Seaweeds:** *Porphyra* as food: Cultivation and economics; Food and other uses, development of cultivation methods, present, and future trends. *Spirulina* as human food: Nutritional aspects. Economic and environmental aspects. Therapeutic applications, harvesting wild populations, Village scale production, Microalgal nutraceuticals, and their production; Cultivated edible kelps: Edible products, kelp composition, kelp production methods, and world production. Some public health aspects of microalgal products. Pheophorbide, Microbial contamination, Extraneous materials, metals, organic compounds, Maintaining sanitary quality.	**10 hours**
	4. **Commercial production and application of algae: *Hydrocolloids*:** History, Chemistry production, and Application, future aspects of alginates, Carrageenans, Agars. An overview of Agarophytes and Carragenanophytes in India. **Lipids and Polyols from microalgae**: History of microalgal lipid production research, Tri-glycerol, Hydrocarbon, carotenoids, polyols. **Hydrogen production by algae:** Water splitting role of algae in hydrogen production, principles of photosynthetic hydrogen production, Bio-photolysis of water. **Products from fossil algae:** Diatomite-industrial mineral, Calcareous algal fossils, and their products, algal kerogen in petroleum and coal. **Biodiesel from Microalgae:** Potential of Microalgal diesel, Micro-algal mass production (Raceway Pond and photobioreactors); Economics of microalgal biodiesel.	**14 hours**

	5. **Algae in Environmental Management:** **Algae and Agriculture:** Free-living cyanobacteria and algalization, *Azolla*, Microalgal soil conditioners, Microalgal plant growth regulation, Biopesticides. Use of seaweeds in agriculture and horticulture. **Microalgae in liquid waste treatment and reclamation:** Biological waste treatment system, Design consideration (Algal concentration, algal productivity), Operation of the integrated algal bacterial system, current application, future application (Sewage grown algae, energy system, toxin removal. **Phycoremediation:** Role of algae in Phytoremediation; Role of physico-chemical parameters on growth and development of algae; Algal survival and pollution: Algal survival under physical and chemical stresses; Responses of algae to pollutants and heavy metal pollution; Uptake and accumulation of xenobiotic substances; Utilization of algae in pollution control; Effluent treatment using algae; Algal biomass and its utilization; Algae as an energy source, Algal biofuels; Industrial collaborations.	**14 hours**
	6. **Harmful Aspects of Algae:** **Marine dinoflagellates blooms:** Dynamics and impacts; Bloom dynamics: Initiation, growth, maintenance, Termination, Ecological and Economic impacts: Negative and Positive impacts. Harmful algal blooms in India. **Hazards of freshwater blue-green algae*:*** (Cyanobacteria) Neurotoxins, Hepatotoxins, other toxins, Medicinal aspects; Human poisoning, contact dermatitis. **Marine biofouling*:*** Bacterial, Microalgal, and Macroalgal biofouling, control treatments; antifouling coatings. Recent improvements in chemical control Methodology, Biological control, Non-adhesive surfaces.	**9 hours**
	7. **Prospects of Algae:** **Algae in space:** Algae and life support systems; Algae and planetary biology, Future of algae in space. Algal Transgenics and Biotechnology. **Algae in Biotechnology:** Algae as a source of bioactive commercial pigments (chlorophylls, phycobilin, and carotenoids); Macro- and micro-algae in the field of Cosmeceuticals, Production of fatty acids (PUFA), vitamins, antioxidants from Algae; Algae as recombinant enzyme bio-factories, production of single cell proteins, Algal production and cultivation, Transgene expression in microalgae; Major algal-based companies in the world, Algal based commercial products in the market, Algal research laboratories across the globe; Use of synthetic biology in the manufacture of by-products from Algae. Bioplastics from seaweeds; Genetic	**6 hours**

	engineering and development of molecular markers.	
Pedagogy:	Lectures/Tutorials/Assignments/Seminars/Visit to Research Laboratories.	
References/ Readings:	**Ahmad, A., Banat, F. and amp; Al Blooshi, H. (eds.).** (2022). Algal Biotechnology: Integrated Algal Engineering for Bioenergy, Bioremediation, and Biomedical Applications. Elsevier. **Alexander, I. and Railkin** (2004). Marine biofouling: colonization processes and defenses. C.R.C. Press L.L.C. **Alexander, M.** (1999). Biodegradation and Bioremediation. Academic Press. **Ayhan Demirbas**. (2008). Biofuels: Securing the Planet's Future Energy Needs. Springer – Verlag London Limited. **Chapman, V. J., and Chapman**, D.J. (1975). The algae, 2nd Edition, Mac. Millan Publ. Inc. New York. **Craig A. Grimes., Oomman** (2008). Light, water, hydrogen: the solar generation of hydrogen by water. Springer Science + Business Media, L.L.C. **Crawford, R.L. and Crawford, D.** (1996). Bioremediation: Principles and Applications. Cambridge University Press, U.K. **David M. Mousdale** (2008). Biofuels: biotechnology, chemistry, and sustainable development. Taylor & Francis Group, L.L.C. **Dean, S. W., Guillermo Hernandez-Duque Delgadillo, James B. Bushman**. (2000). Marine corrosion in tropical environments. American Society for Testing and Materials. **Dey P.M., Jeffrey and B. Harborne** (1997). Plant Biochemistry, Academic Press. **Féron D.** (2001). Marine corrosion of stainless steels. Snippet view West Conshohocken. **Féron, D.** (2021). Marine Corrosion of Stainless Steels: Testing, Selection, Experience, Protection and Monitoring. United States: C.R.C. Press. **Galanakis C.M.** (2020). Microalgae: Cultivation, Recovery of Compounds and applications. Academic Press U.K. **Gerba C.P., Pepper I.L. and Maier R.M.** (2009). Environmental microbiology (*Spirulina*). Elsevier. **Graham, L.E., Graham, J. M. and Wilcox, L.W.** (2009). Algae. Spain: Benjamin Cummings. **Hallmann, A.** (2007). Algal transgenics and biotechnology. Transgenic Plant J, 1(1), 81-98. **Hans-Curt Flemming, P., Sriyutha Murthy. And R. Venkatesan** (2009). Marine and Industrial Biofouling. Springer Verlag Berlin Heidelberg Press. **Harald W. and Tietze.** (1999). Spirulina Micro Food Macro	

	Blessings, Harald W. Tietze Publisher. **Hasanuzzaman, M. and Vara Prasad M.N.** (2020). Handbook of Bioremediation. Physiological, Molecular and Biotechnological Interventions. Springer. **Kevin G. Sellner.** (2009). Physiology, Ecology, and Toxic Properties of Marine Cyanobacteria Blooms. American Society of Limnology and Oceanography Press. **León, R., Cejudo, A. G. and Fernández, E. (Eds.).** (2008). Transgenic microalgae as green cell factories (Vol. 616). Springer Science and Business Media. **Graham L.E., James, M., Graham. And Wilcox, L.W.** (2009). Algae. Benjamin Cummings. **Oskar R. Zaborsky.** (1998). Biohydrogen. Plenum Press, New York. **Robert Edward Lee.** (1999). Phycology (*Spirulina*). Cambridge University Press. **Singh, A. and Ward, O.P.** (2004). Applied Bioremediation and Phytoremediation. Springer. **Stengel, D.B., and Connan, S.** (2015). Marine algae: A source of biomass for biotechnological applications. In Natural products from marine algae (pp. 1-37). Humana Press, New York, NY. **Tiwari B. K., Declan J. Troy. (**2015). Seaweed Sustainability Food and Non-food products Ed, Academic Press Elsevier.	
Learning Outcomes:	Will enable to understand the role of algae in Biotechnology, and Environmental monitoring.	

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