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| **Course No.**  | **:** | **ELE-REE-482** | **Course Title** | **:** | **Waste and By-Products Utilization**  |
| **Semester** | **:** | **VIII** | **Credits** | **:** | **3(2+1)** |

**Syllabus:**

**Theory**

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc., Concept, scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues. Briquetting of biomass as fuel, production of charcoal briquette, concept of vermin-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters , Environmental performance of food industry to comply with ISO-14001 standards

**Practical:**

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water, Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash, Study about briquetting of agricultural residues, Estimation of excess air for better combustion of briquettes, Study of extraction of oil from rice bran, Study on bioconversion of agricultural wastes, Recovery of germ and germ oil from by-products of cereals, Visit to various industries using waste and food by-products.

**Suggested Reading:**

Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.

Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.

Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.

USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.

Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.

V.K. Joshi & S.K. Sharma. Food Processing Waste Management: Treatment & Utilization. New India Publishing Agency.

Vasso Oreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.

Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi

Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi

Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.

**Teaching Schedule:**

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| **Lecture No.** | **Topic** | **Chapter No.** | **Article No.** | **Page Nos.** | **Book No.** |
| 1-4 | Types and Formation of By-products and Waste | 1 | 1.3: 1.3.1, 1.3.4 & Table-4,5 | 5-7, 9-12 | 1 |
| Magnitude of Waste Generation in Different Food Processing Industries | Table-7,8 | 14-15 |
| 5-9 | Uses of different Agricultural By-products from 1. Rice mill
 | 3 | 3.3 | 55-62 | 1 |
| 1. Sugarcane Industry
 | 9 | 9.3.6-9.5.6 | 236-250 |
| 1. Oil mill
 | 10 | 10.6 | 268-273 |
| 10-11 | Concept, Scope and Maintenance of Waste Management | 9 | ----- | 9.1-9.4 | 2 |
| 12-13 | Vermi composting | 14 | ----- | 839-841 | 6 |
| 14-15 | Parameters of Effluent like Temperature, pH, Oxygen Demand (BOD,COD), Fat oil and Grease content, Metal content, Forms of phosphorus, Sulphur in Effluent | 1 | 1.3 | 4-5 | 3 |
| 16-17 | Effluent treatment :1. Pre-treatment of Waste- Sedimentation, Coagulation, Flocculation, Floatation
 | 11 | ----- | ----- | 7 |
| 18-21 | 1. Secondary Treatments- Biological and Chemical Oxygen Demand for Different Food Plant Waste
 | 12&13 | ----- | ----- | 7 |
| 22-23 | 1. Tertiary Treatments- Advance water Treatment Process- Sand, Coal and Activated Carbon Filters
 | 14 | ----- | ----- | 7 |
| 24-27 | Briquetting of Biomass as Fuels | 4 | ----- | 69-89 | 4 |
| 28-29 | Microbiology of Waste and Other Ingredients like Insecticides, Pesticides and Fungicides residues | 15 | ----- | ----- | 7 |
| 30-32 | Environmental Performance of Food Industry to Comply with ISO-14001 standards | 5 | ----- | 63,74,75 | 5 |

**Practical**

1. Determination of temperature, pH, turbidity solids content of waste water.

2. Determination of BOD and COD of waste water.

3. Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash.

4. Study of densification process of agricultural residues.

5. Estimation of excess air for better combustion of briquettes.

6. Study of extraction of oil from agricultural waste.

7. Study on bioconversion of agricultural wastes.

8. Study of biochar preparation process from agro residue.

9. Visit to effluent treatment plant.

10. Visit to various industries using waste and food by-products.

**Suggested Reading:**

1. V.K. Joshi and S.K. Sharma. Food Processing Waste Management; Treatment and Utilization, New India Publishing Agency, New Delhi.
2. USDA. 1992. Agricultural Waste Management Field Hand Book, USDA, Washington DC.
3. Jaidev Singh, 2012. Effluent Treatment Plant; Design, operation and Analysis of Waste Water.
4. N.S. Rathore, N.L. Panwar & A.K. Kurchaina. 2008, Renewable Energy Theory & Practice, Himanshu Publications, 464, sector 11, Hiran Magri, Udaipur.
5. Ioansis S. Arvantitoyannis. Waste management for the Food Industries, Elsevier Academic Press.
6. V.V.N Kishor. Renewable Energy Engineering Technology.
7. ICAR online notes for B.Tech.(Agril. Engg.).

**Reference Books:**

1. Markel, I.A. 1981. Managing Livestock Waste, AVI Publishing Co.
2. Pantastico, ECB. 1975. Post Harvest Physiology, Handling and utilization of Tropical and Sub-tropical fruits and vegetables, AVI Pub. Co.
3. Shewfelt, R.L. and Prussi, S.E. 1992. Post-Harvest Handling – A Systems approach, Academic Press Inc.
4. Weichmann J. 1987. Post Harvest Physiology of vegetables, Marcel and Dekker Verlag.
5. VassoOreopoulou and Winfried Russ (Edited). 2007. Utilization of By-products and Treatment of waste in the Food Industry. Springer Science & Business media, LLC 233 New York.
6. Prashar, Anupama and Bansal, Pratibha. 2007-08. Industrial Safety and Environment. S.K. Kataria and sons, New Delhi
7. Garg, S K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
8. Bhatia, S.C.. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.