Resolution Number : AC/II (20-21).2.RUS20

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE

Explore ● Experience ● Excel

Syllabus for Semester V & VI

Program: B.Sc. Non-Conventional Energy Sources and Waste Recycling

Program code : RUSACNCE

(Credit Based Semester and Grading System with effect from the academic year 2023-24)

PROGRAM OUTCOMES

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Bachelors Program in Science also encourages students to reflect on the broader purpose of their education.

PO	Description
A student completing Bachelor's Degree in Science program will be able to:	
PO 1	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science.
PO 2	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
PO 3	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
PO 4	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
PO 5	Take complex challenges, work responsibly and independently, as well as in cohesion with a team for completion of a task. Communicate effectively, convincingly and in an articulate manner.
PO 6	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
PO 7	Follow ethical practices at work place and be unbiased and critical in interpretation of scientific data. Understand the environmental issues and explore sustainable solutions for it.
PO 8	Keep abreast with current scientific developments in the specific discipline and adapt to technological advancements for better application of scientific knowledge as a lifelong learner.

PROGRAM SPECIFIC OUTCOMES

PSO	Description
A student completing Bachelor Degree in science program with applied component as NCE-WR will be able to:	
PSO 1	Recognize the issues faced by our environment, and the repercussions of its mishandling which they, and their future generations would most suffer from in the coming years.
PSO 2	Devise suitable actions that are needed to reform the society to avert the environmental crisis ..
PSO 3	Develop the sense of rights and responsibilities towards the resources that support us.
PSO 4	Create awareness in self & the society that , solution to each and every problem begins with oneself .

PROGRAM OUTLINE

SEMESTER V			
Course Code	**Unit**	**Course Title / Unit Title**	**Credits**
RUSACNCE501	**Non-Conventional Sources of Energy & Waste Recycling**		**2**
	I	**NON-CONVENTIONAL SOURCES OF ENERGY:** Perspectives on Energy Sources and Utilization	
	II	Study of the following non-conventional energy sources with respect to scope, present scenario, applications, limitations and future prospects: • Solar Energy • Wind Energy • Geothermal Energy:	
	III	**WASTE RECYCLING:** Introduction to waste management. Management of gaseous waste	
	IV	Introduction to liquid waste Particulate matter and its management	
RUSACNCEP501	**Practical**		**2**

SEMESTER VI			
Course Code	**Unit**	**Course Title / Unit Title**	**Credits**
RUSACNCE601	**Non-Conventional Sources of Energy & Waste Recycling**		**2**
	I	Ocean Thermal Energy Conversion Tidal Energy Fuel Cells and Hydrogen as a potential fuel	
	II	Biomass	
	III	Solid Waste Management	
	IV	Liquid Waste Management	
RUSACNCEP601	**Practical**		**2**

SEMESTER V

Course Code : RUSACNCE501

Course Title : Non-Conventional Sources of Energy & Waste Recycling

Academic year 2020-21

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Comprehend the need for energy from the perspective of man, and describe the various energy sources.
CO 2	Define energy efficiency, and correlate the current energy crisis with the energy efficiency gap
CO 3	Review different non-conventional energy sources such as solar, wind, geothermal, etc. and assess them critically with respect to feasibility and energy value.
CO 4	Define the concept of waste, and illustrate the different methods of waste disposal.
CO 5	Evaluate the parameters to judge the quality of water and management of gaseous waste.

DETAILED SYLLABUS

RUSACNCE501	**Non-Conventional Sources of Energy & Waste Recycling**		**Credits-02**
	Unit	**Unit Title**	**Lectures**
	I	**Perspectives on Energy Sources and Utilization:** **1.1.** Definitions, units and concept, energy requirements of man and society, unequal distribution of energy resources around the world, Energy consumption patterns, Contrast in energy demands of developed, developing and under-developed countries. **1.2.** Sector wise need for energy: Domestic, industrial, agricultural, and transport sectors. Environmental implications of energy use, Concept of sustainable development and its energy execution, Energy audit and its types. **1.3.** Various types of energy sources, conventional/ non-conventional,	**(15L)**

		renewable / non-renewable, fossil fuels: coal, oil, natural gas; thermal, hydroelectric and nuclear. **1.4.** Energy storage and conservation methods. Role of government and Non-Governmental Organizations, socio-economic aspects, Government policies. **1.5.** Fundamentals of energy efficiency, the energy efficiency gap, participants in the field of energy efficiency, Energy efficiency policies. **1.6.** The climate debate: History of climate policy, clashing positions on climate change: skeptics and supporters, climate realists, case studies on climate change activism around the world. Role of individual on the climate crisis, concept of carbon footprint. **1.7.** Entrepreneurship opportunities in the energy sector.	
	II	**Study of the following non-conventional energy sources with respect to scope, present scenario, applications, limitations and future prospects:** **2.1 Solar Energy** **2.1.1** Solar spectrum and its relevance as the energy source, solar radiation, conversion of solar energy into heat energy in solar collectors, Fresnel lenses, parabolic reflectors. **2.1.2** Photovoltaic effect, semi-conductors as solar energy converters, different materials used, factors affecting photovoltaic efficiency, effect of temperature, solar cells. **2.1.3** Photo-electrochemical process for the conversion of solar energy; **a**pplications of solar energy for different purposes. **2.2 Wind Energy** **2.2.1** Wind velocity and generation of wind energy **2.2.2** Types of wind mills and their working, rotor with blades, gear generator, vertical and horizontal axis of rotation. **2.3 Geothermal Energy:**	**(7L)** **(4L)** **(4L)**

		2.3.1: Origin of geothermal heat, temperature gradient, geothermal steam and hot spring, geysers. **2.3.2:** Power production from geysers, mantle as heat source.	
	III	**WASTE RECYCLING:** **3.1 Introduction to waste management**: **3.1.1**Definition of waste, types of waste, changing trends in waste generation, resources, development, population and waste generation, concept of waste management and approaches to it: end of the pipe treatment, in plant treatment, goal of zero waste and its feasibility, Introduction to green chemistry. **3.1.2** Waste disposal and its three 'R"s Recovery, reuse, recycle and disposal of waste, economic viability of each of the above, waste audit. **3.1.3** Waste generation: Types of waste on the basis of usage, sources, physical state, feasibility with respect to three Rs. domestic, industrial, agricultural and commercial wastes; gaseous, solid and liquid waste. **3.2 Management of gaseous waste:** **3.2.1**: Generation of gaseous waste, smoke, fog mist, emission of gases, Sources, contribution of different sources to total waste. Effects: vehicular and chimney exhaust **3.2.2** Treatment methods, adsorption, absorption, catalytic conversion, their feasibility cost and regulation **3.2.3** Minimization methods, economic viability of reuse.	**(9L)** **(6L)**
	IV	**4.1 Introduction to liquid waste** **4.1.1**: Liquid Waste: Generation, local and global sources, variation in the amount generated. **4.1.2** Characterization of liquid waste **4.1.3** Physical parameters; colour, odour, turbidity, TSS. TDS, TS **4.1.4** Chemical parameters: pH, acidity, alkalinity, hardness, DO, COD, TOC,	**(8 L)** **(7 L)**

		THOD and BOD, chemical composition, classification. **4.2 Particulate matter and its management:** **4.2.1:** Particulate matter: sources, relation to energy consumption, characterization, effects. **4.2.2** Disposal methods, cyclone separator, wet scrubber,electrostatic precipitator, fabric filter. **4.2.3** Regulations and their implementation in case of waste disposal, Role of the government.	

Semester-V
Practical

RUSACNCEP501	**Non-Conventional Sources of Energy & Waste Recycling**		**Credits-02**
	1.	Determination of acidity, alkalinity and hardness of the given water sample.	
	2.	Construction of the breakthrough curve and determination of breakthrough capacity of the given ion exchanges resin.	
	3.	Determination of T.S., T.S.S. and T.D.S. present in the given water sample.	
	4.	Estimation of chloride in water sample by argentometric method	
	5.	Determination of nitrite colorimetrically from the waste water sample.	
	6.	Determination of sulphate in the given water sample by benzidine sulphate method.	
	7.	Determination of Cr (VI) spectrophotometrically in the given water sample.	
	8.	Determination of phosphates in water by stannous chloride method.	
	(2 experiments to be done at the time of examination)		

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment – 40 % (40 marks).

Sr No	Evaluation type	Marks
1	One class Test (multiple choice questions / objective)	20
2	Seminar Presentations/ Assignments	15
3	Active participation in routine class activities	05
	Total	**40 Marks**

B) External examination - 60 %

Semester End Theory Assessment - 60% **60 marks**

i. **Duration -** These examinations shall be of **two hours** duration.

ii. Theory question paper pattern: -There shall be **four** questions each of **15** marks, one on each unit. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1) a)	Any 3 out of 5	12	Unit I
Q.1) b)	Any 1 out of 2	03	
Q.2) a)	Any 3 out of 5	12	Unit II
Q.2) b)	Any 1 out of 2	03	
Q.3) a)	Any 3 out of 5	12	Unit III
Q.3) b)	Any 1 out of 2	03	
Q.4) a)	Any 3 out of 5	12	Unit IV
Q.4) b)	Any 1 out of 2	03	

Practical Examination Pattern:

A) Internal Examination: - 501

Activity	Marks
Internal of Practical Test	10
Laboratory work	15
Biogas Plant Maintenance or site visit with relevant reports	15
Total	**40**

B) External Examination 501
(Semester end practical examination):-60 Marks

Sr. No.	Particulars	Marks
1	Laboratory Work	25 + 25
2	Viva and Journal	5+ 5
Total		**60**

PRACTICAL BOOK / JOURNAL:

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Project Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Course	501		Total
	Internal	External	
Theory	**40**	**60**	**100**
Practicals	**40**	**60**	**100**

(Total Marks : 200)

Semester - VI
Course Code: RUSACNCE601
Course Title: Non-Conventional Sources of Energy & Waste Recycling
Academic year 2020-21

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Summarize the ocean-based non-conventional energy sources- namely OTEC and Tidal, and appraise them in keeping with the current local and global scenario.
CO 2	Explain the construction and working of fuel cells, and recognize their potential as the solution to the global energy crisis
CO 3	Explore the prospects of hydrogen as a fuel.
CO 4	Define biomass, describe the use of biomass as an energy source.
CO 5	Outline the use of biomass in India.
CO 6	Characterize the management of solid waste with respect to its sources, and disposal methods.
CO 7	Appreciate the significance of recycling, reuse & reclamation of solid waste.
CO 8	Describe the various treatment methods used for three step (physical, chemical and biological processes) treatment of liquid waste in general, applications in specific industries like fertilizer, food & beverage, petrochemical industry.
CO 9	Examine the government policies and regulations with regarding consumable and non-consumable water.

DETAILED SYLLABUS

RUSACNCE601	Non-Conventional Sources of Energy & Waste Recycling		Credits-02
	Unit	**Unit Title**	**Lectures**
	I	**Study of the following non-conventional energy sources** **1.1 Tidal Energy:** **1.1.1**:Tide height and its potential for power generation. **1.1.2:** Construction of dam across sea basin, installation of the turbine, specification of the basin. **1.2. Ocean Thermal Energy Conversion** **1.2.1** Difference in surface temperatures and at a depth in ocean, its use as a source for power generation **1.2.2**Requirements for a practical OTEC plant, different working fluids. **1.2.3** Relevance to the present scenario, feasibility and future projection. **1.3. Fuel Cells:** **1.3.1** Electrochemical energy conversion, basic principle of fuel cells, advantages of energy conversion in fuel cells, distinction between fuel cell and battery. **1.3.2** Hydrogen – oxygen fuel cell, organic oxygen fuel cell **1.3.3** Applications of fuel cells. **1.4 Use of hydrogen as a potential fuel:** availability, generation and use, feasibility and economic viability, advantages**,** Economically viable hydrogen production, photolysis of water.	**(3L)** **(6L)** **(3L)** **(3L)**
	II	**Biomass:** **2.1** Solar energy and generation of biomass, Bio-energy: Biomass as a resource, Advantages of biomass energy among alternative resources, opportunities and challenges, forms of biomass: solid, liquid, gas.	**(15L)**

		2.2 Biomass properties, types and energy value, utilization with and without conversion. **2.3** Importance of lignin with respect to biomass energy, lignin content in various biomass, Non-lignocellulosic biomass (algae) and microalgae cultivation, macroalgae (seaweed) cultivation. **2.5** Biomass processing methods: Physical, thermochemical (pyrolysis, torrefaction, gasification, trans-esterification), biochemical (anaerobic digestion, fermentation, enzymatic conversion). **2.6** Biogas and biofuels: Production and case studies on its use. Contribution of biomass-based energy resources on India's energy use, Role of government, policies introduced as incentives for furthering biomass energy resources, role of NGOs.	
	III	**WASTE RECYCLING:** **3.1 Solid Waste Management**: **3.1.1** Solid waste, sources and their characterization. **3.1.2** Classification of solid waste: chemical nature, biodegradable and non bio-degradable, their feasibility with respect to the use of three 'R's. **3.1.3** Feasibility of recycling: metal, paper, plastic rubber and glass, costs and economic viability, need of the treatment at the source level, role of the government and awareness in citizens. **3.1.4:** Methods of disposal of solid waste: **3.1.4.1** Dumping of garbage, **3.1.4.2** Sanitary landfills, **3.1.4.3** Composting, soil conditioning, vermi-composting. **3.1.4.4** Incineration; **3.1.5** Hazardous and toxic waste, definition, classification, difference between the hazardous and toxic waste, methods of minimization/	**(15L)**

		3.1.6 Radioactive waste: sources, effects on plants, animal and man, activity level and its management, minimization and treatment. **3.1.7**e-waste: types, effects and management. **3.1.8**Hospital and medical waste, disposal and preventive measures. **3.1.9** Disaster management and risk analysis, restriction of hazardous substances.	
	IV	**Liquid Waste Management:** **4.1** Waste water, industrial effluent, need for the treatment**. sources,** **4.2**Use of COD, BOD and TOC for deciding the treatment process. **4.3**Pre-primary treatment: neutralization, equalization. **4.4**Primary treatment: screening, sedimentation, coagulation, filtration **4.5** Secondary treatment: principles of the biological treatment of liquid waste, **4.6** Various processes used: aerobic and anaerobic process. **4.6.1** Aerobic process, oxidation ponds, oxidation ditch, Aerated lagoons, activated sludge process and trickling filter process. **4.6.2** Anaerobic processes, anaerobic contact process **4.7** Tertiary treatment: reverse osmosis, ultrafiltration, electro-dialysis, ion exchange, ozone treatment. **4.8** Government regulations, permissible levels for drinking water and for other uses. **4.10** Characterization of effluent from i) Petrochemical ii) food and beverage iii) Fertilizer industry.	**(15L)**

Semester-VI
Practical

RUSACNCEP601	Non-Conventional Sources of Energy & Waste Recycling		Credits-02
	1.	Determination of COD of the waste water sample.	
	2.	Determination of dissolved oxygen present in the given water sample.	
	3.	Determination of dosage of coagulant by Jar Test.	
	4.	Determination of iron in water sample by phenanthroline method / AAS method	
	5.	**Group Activities:**	
	6.	Preparation of Biofuel from waste oil	
	7.	Soil analysis.	
	8.	Introduction to survey methodology, designing mock surveys in relation to non-conventional energy sources and waste recycling.	

REFERENCE BOOKS

1.Solar energy: principles of thermal collection and storage – S.P. Sukhatme, Tata Mcgraw Hill, New Delhi 1990.

2.Fuel Cell Will Mitchell, Academic Press 1963.

3.Photo electrochemical Cells: Studies in Physical and theoretical Chemistry,Vol.50 K.V.S.Santham & M.Sharma, Elsevier Publishing Company, Amsterdam,1988.

4. Wastewater Treatment and pollution control : S.A.Arsewala, Tata Mcgraw Hill, New Delhi 1990.

5.Pollution Control in Process Industries: S.P.Mahajan, Tata Mcgraw Hill, New Delhi 1990.

6. Waste Water Treatment: M.N. Rao and A.K. Datta, Oxford and IBH Publishing.

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment –40 % (40 marks).

Sr No	Evaluation type	Marks
1	One class Test (multiple choice questions / objective)	20
2	Seminar Presentations/ Assignments	15
3	Active participation in routine class activities	05
	Total	**40 Marks**

B) External examination - 60 %

Semester End Theory Assessment - 60% **60 marks**

i)Duration - These examinations shall be of **two hours** duration.

ii)Theory question paper pattern: -There shall be **four** questions each of **15** marks, one on each unit. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1) a)	Any 3 out of 5	12	Unit I
Q.1) b)	Any 1 out of 2	03	
Q.2) a)	Any 3 out of 5	12	Unit II
Q.2) b)	Any 1 out of 2	03	
Q.3) a)	Any 3 out of 5	12	Unit III
Q.3) b)	Any 1 out of 2	03	
Q.4) a)	Any 3 out of 5	12	Unit IV
Q.4) b)	Any 1 out of 2	03	

Practical Examination Pattern:

A) Internal Examination: - 601

Activity	Marks
Internal of Practical Test	10
Laboratory work	15
Biogas Plant Maintenance or site visit with relevant reports	15
Total	**40**

B) External Examination 601
(Semester end practical examination):-60 Marks

Sr. No.	Particulars	Marks
1	Laboratory Work	25
2	Viva and Journal	5+5
3	Project work	25
Total		60

PRACTICAL BOOK / JOURNAL:

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.
In case of loss of Journal and/ orProject Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Course	601		
	Internal	External	Total
Theory	40	60	100
Practicals	40	60	100

(Total Marks : 200)