

**Resolution Number : AC/II (20-21).2.RUS15**

**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. (Drugs & Dyes)**  
**Program Code :(RUSACDD)**

**(Credit Based Semester and Grading System with effect  
from the academic year 2020-21)**

## 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
<b>A student completing Bachelor's Degree in Science program will be able to:</b>	
<b>PO 1</b>	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.
<b>PO 2</b>	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
<b>PO 3</b>	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
<b>PO 4</b>	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
<b>PO 5</b>	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.
<b>PO 6</b>	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
<b>PO 7</b>	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.
<b>PO 8</b>	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
<b>A student completing Bachelor's Degree in Science program with applied component as Drugs &amp; Dyes will be able to:</b>	
<b>PSO 1</b>	Appreciate the vista of applications of chemistry in the fields of drugs and dyes..
<b>PSO 2</b>	Become aware of the ways in which the science has, and can be applied to real problems.
<b>PSO 3</b>	Become cognizant of the important contributions of chemistry in the two fields of drugs and dyes, and apply their knowledge of molecules and the way in which they prefer to behave in specific situations.

## PROGRAM OUTLINE

<b>SEMESTER V</b>			
<b>Course Code</b>	<b>Unit</b>	<b>Course Title / Unit Title</b>	<b>Credits</b>
<b>RUSACDD501</b>	<b>Drugs and Dyes</b>		
	<b>I</b>	General Introduction to Drugs Routes of Drug Administration and Dosage Forms Pharmacodynamic agents	<b>2</b>
	<b>II</b>	Anti-Neoplastic Drugs Anti HIV Drugs Cardiovascular Drugs Antidiabetic Agents Anti parkinsonism Drugs Drugs for Respiratory System	
	<b>III</b>	Introduction to Dyestuff Chemistry Classification of dyes based on constitution Classification Based on Application	
	<b>IV</b>	Intermediates Preparation of intermediates Dyeing method of cotton fibres	
<b>RUSACPDD501</b>	<b>Practical</b>		<b>2</b>

<b>Semester VI</b>			
<b>Course Code</b>	<b>Unit</b>	<b>Course Title/Unit Title</b>	<b>Credits</b>
<b>RUSACDD601</b>	<b>Drugs &amp; Dyes</b>		
	I	Drug Discovery, Design and Development Drug Metabolism Chemotherapeutic Agents Antibiotics Antimalarials	<b>2</b>
	II	Anti-inflammatory Drugs Antiamoebic Drugs Antitubercular Drugs Antileprotic Drugs Drug Intermediates Nano particles in Medicinal Chemistry	
	III	Colour and chemical constitution of dyes Non-textile Uses of Dyes Optical brighteners Organic Pigments	
	IV	Synthesis of specific dyes and their uses Types of fibres and classes of dyes applicable to them Ecology and toxicity of dyes	
<b>RUSACPDD601</b>	<b>Practical</b>		<b>2</b>

**Semester V**  
**Course Code: RUSACDD501**  
**Course Title: Drugs & Dyes**  
**Academic year 2020-21**

**Course Outcomes:**

After completing the course, the learner will be able to -	
<b>CO 1</b>	Understand various pharmacodynamic agents with respect to their chemical structure, chemical class, therapeutic uses, and side effects.
<b>CO 2</b>	Understand different routes of drug administration.
<b>CO 3</b>	Describe the metabolism of drugs inside the human body.
<b>CO 4</b>	Enlist different routes of drug administration.
<b>CO 5</b>	Classify dyes based on their constitution and application.
<b>CO 6</b>	Correlate color and chemical constitution of dyes.
<b>CO 7</b>	Write the reactions involved in the synthesis of some representative drugs and dye intermediates.

**DETAILED SYLLABUS**

<b>Course Code</b>	<b>Drugs &amp; Dyes</b>		<b>Credits-02</b>
<b>RUSACDD501</b>	<b>Unit</b>	<b>Unit Title</b>	<b>Lectures</b>
	<b>I</b>	<b>1.1 General Introduction to Drugs</b>	<b>(6L)</b>
		<b>1.1.1</b> Definition of a drug, Requirements of an ideal drug, Classification of drugs (based on therapeutic action).	
		<b>1.1.2</b> Nomenclature of drugs: Generic name, Brand name, Systematic name	
		<b>1.1.3</b> Definition of the following medicinal terms; Pharmacon, Pharmacophore, Prodrug, Half-life efficiency, LD50, ED50, Therapeutic Index.	<b>(2L)</b>  <b>(7L)</b>

	<p><b>1.1.4</b> Brief idea of the following terms:          Receptors, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.</p> <p><b>1.2. Routes of Drug Administration and Dosage Forms</b></p> <p><b>1.2.1</b> Oral and Parenteral routes with advantages and disadvantages.</p> <p><b>1.2.2</b> Formulations, Different dosage forms (emphasis on sustained release formulations.)</p> <p><b>1.3. Pharmacodynamic agents</b>          A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects</p> <p><b>1.3.1 CNS Drugs:</b>          Classification based on pharmacological actions, Concept of sedation and hypnosis, anaesthesia. Phenobarbitone (Barbiturates – mode of action), Phenytoin (Hydantoins), Trimethadione (Oxazolinediones), Piracetam (Pyranones), Midazolam, Alprazolam (Benzodiazepines)          Methylphenidate (Piperidines)          Chlorpromazine (Phenothiazines)          Fluoxetine (Phenyl propyl amines)</p>	
--	--	--





		<p><b>2.3.1.</b> Introduction, Classification based on pharmacological action</p> <p><b>2.3.2.</b> Enalapril (-amino acids), Isosorbide dinitrate (Nitrates), Atenoldol (Aryloxy propanol amines), Nifedipine (Pyridines), Furosemide (Sulfamyl benzoic acid), Synthesis of Furosemide, Atenolol</p> <p><b>2.3.3.</b> Drug Therapy and Renin-Angiotensin System.</p> <p><b>2.4 Antidiabetic Agents</b></p> <p><b>2.4.1.</b> Introduction and types of diabetes; Insulin therapy</p> <p><b>2.4.2.</b> Antidiabetic agents - Glibenclamide (sulphonyl ureas – mode of action), Metformin (Biguanides)</p> <p><b>2.5 Antiparkinsonism Drugs</b></p> <p><b>2.5.1.</b> Introduction</p> <p><b>2.5.2.</b> Procyclidine hydrochloride (Pyrrolidines), Ethopropazine hydrochloride (Phenothiazines), Laevodopa (alpha-amino acids) Synthesis of Levodopa from Vanillin.</p> <p><b>2.6 Drugs for Respiratory System</b></p> <p><b>2.6.1.</b> General idea of Expectorants; Mucolytes; Bronchodilators Decongestants and Antitussives</p> <p><b>2.6.2.</b> Bromhexine hydrochloride (Phenyl methyl amines), Salbutamol, Pseudoephedrine (Phenyl ethyl amines) Oxymetazoline (Imidazolines) Codeine Phosphate (Opiates)</p>	
--	--	--	--

		Synthesis of Salbutamol	
	<b>III</b>	<b>3.1 Introduction to Dyestuff Chemistry</b> <b>3.1.1</b> Important landmark in the history of dyes <b>3.1.2.</b> Natural colouring matter and their limitations: e.g., Heena, Turmeric, kesar, Chlorolphyll, Indigo, Alizarine from roots of madder plants, Logwood. Tyrian Purple. (5L)	
		<b>3.1.3.</b> Synthetic Dyes: Important milestones, i.e. Mauve, Diazotization, aniline Yellow, Congo Red, Synthesis and structure of Indigo, disperse Dye, fluorescent Brighteners, procion reactive Dyes, Remazole Dyes. (Emphasis on Name of the Scientist and dyes and the year of the discovery is required and structure is not expected. (5L)	
		<b>3.1.4.</b> Definition of dyes, Properties i.e. colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, fastness properties, substantivity, Economic viability. (5L)	
		<b>3.1.5.</b> Explanation of nomenclature of commercial dyes with at least one example. Suffixes-G, O, R, B, 6B, GK, 3GK, 6GK, L, S Explanation: naming of dyes by colour index(two examples) (5L)	
		<b>3.2. Classification of dyes based on constitution</b>	

	<p>(Examples are mentioned below with structures)</p> <p>Nitro Dyes-Napyhol yellow S, Nitroso Dye-Gambine Y, Azo Dyes-</p> <p>(a) Monoazo Dyes- Metanil yellow</p> <p>(b) DiazoDyes- Naphthol Blue Black</p> <p>(c)Triazodyes -Chloroamine Green B, Diphenylmethane Dyes-Auramine G, Triphenyl methane</p> <p>Dyes-</p> <p>(a) Malachite Green Series- Naphthalene green V (b) Magenta Series- Acid Magenta</p> <p>(c) Rosolic acid series-Chrome Violet, Heterocyclic Dyes, Xanthene-Rhodamine 6G, Acridines-Acriflavine, Azines-Safranin B, Oxazines-Capri blue, Thiazines-Methylene Green, Quinolines-Quinoline Yellow, Thiazoles-Primuline, Benzoquinones and naphthaquinones – Naphthazarin, Anthraquinone Dyes-Indanthrene, Turquoise Blue 3GK, Indigoids-Indigo Carmine, Phthocyanines-Sirius Light green FFGL</p> <p><b>3.3 Classification Based on Application</b></p> <p>Definition, fastness properties &amp; applicability on substrates examples with structures (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, Victoria Blue B (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes-Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG</p>	
--	--	--

		(e) Mordant Dyes-Erichrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, Indanthrene Red 5GK. (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, perlon fastblue FFR (i) Reactive Dyes-cibacron Brillant Red B,procion briilant Blue HB.	
	<b>IV</b>	<p><b>4.1 Intermediates</b></p> <p><b>4.1.1.</b> A brief idea of Unit processes</p> <p><b>4.1.2.</b> Introduction of primary intermediates, unit processes</p> <p><b>4.1.3.</b> Nitration, Sulphonation, Halogenation, Diazotization: 3 different methods, importance, Ammonolysis, Oxidation N.B.: Definition, Reagents Examples with reaction conditions (mechanism is not expected)</p> <p><b>4.2 Preparation of the following Intermediates.</b></p> <p><b>4.2.1</b> Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; phenol; resorcinol; sulphanilic acid; o-,m-,p-chloronitrobenzenes; o-,m-,p-nitroanilines; o-,m-p- phenylene diamines; Naphthol ASG.</p> <p><b>4.2.2</b> Naphthalene derivatives: <math>\alpha,\beta</math>-Naphthols; <math>\alpha,\beta</math>-Naphthylamines; Schaeffer acid, Tobias acid;</p>	<p>(5L)</p> <p>(7 L)</p> <p>(3L)</p>

		<p>Naphthionic acid; N.W. acid; Clev-6-acid; H acid; Naphthol AS.</p> <p><b>4.2.3 Anthracene derivatives:</b></p> <p>1Nitroanthraquinone; 1Aminoanthraquinone; 2-Aminoanthraquinone; 2-Methylantraquinone; anthraquinone-1-sulphonic acid; Anthraquinone-2-sulphonic acid; 1-Chloroanthraquinone; Chloroanthraquinone; Benzanthrone.</p> <p><b>4.3 Dyeing Method of Cotton Fibres</b></p> <p><b>4.3.1</b> Direct dyeing, Vat dyeing, Mordant dyeing, Disperse dyeing</p> <p><b>4.3.2</b> Forces binding of dyes to the fibres: Ionic forces, Hydrogen bonds, Van-der-Wall's forces, Covalent linkages.</p>	
--	--	--	--

## Semester V Practical

RUSACPDD501	Drugs & Dyes		Credits
		<b>Drug preparation</b>	<b>02</b>
	<b>1.</b>	Preparation of Methyl Salicylate from Salicylic Acid	
	<b>2.</b>	To write the monograph of Paracetamol and Aspirin from I.P.	
		<b>Drug Estimation</b>	
	<b>1.</b>	Estimation of Ibuprofen	
	<b>2.</b>	Estimation of Acid neutralizing capacity of antacid	
		<b>Dyes Preparation</b>	
	<b>1.</b>	Preparation of Orange-II	
	<b>2.</b>	Preparation of p-Nitroacetanilide from Acetanilide	
		<b>Dyes Estimation</b>	
	<b>1.</b>	Estimation of Primary amino group by diazotization	

### References:

1. Medical Chemistry by V K Ahluwalia, Madhu Chopra, Ane's Books Pvt. Ltd.
2. Organic Chemistry of Drug Discovery and Drug Design – Richard B. Silvermann
3. Medicinal Chemistry – Shreeram and Yogeshwari (Pearson)
4. Chemistry of dyes and principles of dyeing, Shenai V.A., Sevak publications, 1973

## MODALITY OF ASSESSMENT

### Theory Examination Pattern:

A) Internal Assessment 40%		40 Marks
Sr No	Evaluation type	Marks
1	One Assignment	10
2	One class Test (multiple choice questions / objective/ drawing structure of drugs and dyes)	20
3	Active participation in class	05
4	Overall conduct, participation in curricular and co-curricular activities.	05

### B) External Examination – 60% (60 Marks)

#### Semester End Theory Examination-

- 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

Particulars	Marks
Journal	05
Experimental Work	30
Active Participation	05
<b>Total</b>	<b>40</b>

**B) External Examination: Semester end practical examination 60 M**

Sr.No.	Particulars	Marks
1)	Laboratory Work	25 + 25
2)	Viva- Voce	05 + 05
	<b>Total</b>	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 Report, a Lost Certificate should be obtained from Head/ Coordinator / 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	RUSACDD501		Total
	Internal	External	
Theory	40	60	100
Practical's	40	60	100



**SEMESTER VI**  
**Course Code: RUSACDD601**  
**Course Title: Drugs & Dyes**  
**Academic year 2020-21**

**Course Outcomes :**

After studying the course, the learner will be able to:	
<b>CO 1</b>	Outline the principles involved in drug designing and metabolism of drugs inside the human body.
<b>CO 2</b>	Classify various chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, and side effects
<b>CO 3</b>	Compare the relation between color and chemical constitution of dyes.
<b>CO 4</b>	Explore various applications of dyes.
<b>CO 5</b>	Write the reactions involved in the synthesis of some representative drugs and dye intermediates.

**DETAILED SYLLABUS**

Course Code		Drugs & Dyes	Credits-02
RUSACDD601	<b>Unit</b>	<b>Unit Title</b>	<b>Lectures</b>
	<b>I</b>	<b>1.1 Drug Discovery, Design and Development</b>	<b>(5L)</b>
		<b>1.1.1</b> Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation.	
		<b>1.1.2</b> Drug development from Natural Sources: Anti infective agents Anti cancer agents CNS agent	<b>(4L)</b>
	<b>1.1.3</b> Development of drug: The Pharmacophore identification, modification of structure or functional	<b>(6L)</b>	

	<p>group, Structure activity relationship (Benzodiazepines, Sulphonamides).</p> <p><b>1.1.4</b> Structure modification to increase potency: Homologation, Chain branching, Ring-chain transformation, Extension of the structure.</p> <p><b>1.1.5</b> Computer assisted drug design.</p> <p><b>1.2 Drug Metabolism</b></p> <p><b>1.2.1.</b> Introduction, Absorption, Distribution, Bio-transformation, Excretion.</p> <p><b>1.2.2.</b> Different types of chemical transformation of drugs with specific example</p> <p><b>1.3 Chemotherapeutic Agents</b></p> <p>Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, and side effects.</p> <p><b>1.3.1 Antibiotics</b></p> <p>Definition, Characteristics and properties of: Amoxicillin; Cloxicillin (lactum antibiotics) Cephalexin (Cephalosporins), Doxycycline (Tetracyclines), Gentamycin (Aminoglycosides), Ciprofloxacin (Quinolones)</p> <p>Synthesis of Ciprofloxacin</p> <p><b>1.3.2 Antimalarials</b></p> <p>Types of malaria: Symptoms; pathological detection during window period (Life cycle of the parasites not to be discussed) Chloroquine (3-Amino quinolines) Paludrine (Biguanides) Pyrimethamine (Diamino pyrimidines) Artemether (Benzodioxepins)</p>	
--	---	--

	<p>Following combination to be discussed</p> <p>(i) Sulfadosine-Pyrimethamine</p> <p>(ii) Atremether-Lumefantrine (no structure)</p> <p>Synthesis of Paludrine.</p>	
<b>II</b>	<p><b>2.1 Anti-inflammatory Drugs</b></p> <p><b>2.1.1.</b> Mechanism of inflammation and various inflammatory conditions.</p> <p><b>2.1.2.</b> Prednisolone, Betamethasone (Steroids), Aceclofenac (N- Aryl anthranilic acids), Mefanic Acid (N-Aryl anthranilic acids). Synthesis of Aceclofenac.</p> <p><b>2.2 Antiamoebic Drugs</b></p> <p><b>2.2.1.</b> Types of Amoebiasis</p> <p><b>2.2.2.</b> Metronidazole; Diloxamide furoate (Furans)</p> <p><b>2.2.3.</b> Following combination therapy to be discussed: Ciprofloxacin-Tinidazo Synthesis of Metronidazole</p> <p><b>2.3 Antitubercular Drugs</b></p> <p><b>2.3.1.</b> Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis.</p> <p><b>2.3.2.</b> General idea of Antibiotics used in their treatment.</p> <p><b>2.3.3.</b> Streptomycin, Rifampin, PAS (Aminosalicylates), Isoniazide (Hydrazides), Pyrazinamide (Pyrazines), (+) Ethambutol (Aliphatic diamines) Synthesis of Ethambutol.</p> <p><b>2.4 Antileprotic Drugs</b></p>	<p>(2L)</p> <p>(3L)</p> <p>(2L)</p> <p>(3L)</p> <p>(2L)</p> <p>(3L)</p>

	<p><b>2.4.1.</b> Introduction, Types</p> <p><b>2.4.2</b> Classification of anti-leprotic agents</p> <p>Ethionamide (Thioamides), Dapsone (Sulfonamides), Clofazimine (Phenazines)</p> <p>Synthesis of Dapsone</p> <p><b>2.4.3.</b> Following combination therapy to be discussed for the treatment of Tuberculosis and Leprosy:</p> <p>(i) Rifampin + Ethambutol + Pyrazinamide</p> <p>(ii) Rifampin + Isoniazide + Pyrazinamide</p> <p>(iii) Rifampin + Clofazimine + Ethionamide.</p> <p><b>2.5 Drug Intermediates: Synthesis and uses</b></p> <p>(i) 2,4,5-Triamino-6-hydroxypyrimidine from Guanidine.</p> <p>(ii) 3-Chloro-5-sulphonyl amino anthranilic acid from 3-Chloro-2-toluidine</p> <p>(iii) p-[2'-(5-Chloro-2-methoxybenzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2-methoxybenzoate</p> <p>(iv) 4-(p-Chlorophenyl)-4-hydroxypiperidine from 4-Chloroacetophenone.</p> <p>(v) p-Acetyl amino benzenesulphonyl chloride from Aniline</p> <p>(vi) Epichlorohydrine from propene.</p> <p><b>2.6 Nano particles in Medicinal Chemistry</b></p>	
--	---	--

	<p><b>2.6.1.</b> Introduction, Carbon nano particles (structures), Carbon nano tubes: Functionalisation for Pharmaceutical applications. Targeted drug delivery in vaccine (Foot and mouth disease) Use in Bio-physical treatment.</p> <p><b>2.6.2</b> Gold nano particles in treatment of cancer, Parkinsonism, Alzheimer.</p> <p><b>2.6.3.</b> Silver nano particles: Antimicrobial activity.</p>	
<b>III</b>	<p><b>3. 1 Colour and chemical constitution of dyes</b></p> <p><b>3.1.1</b> Absorption of visible light, colour of wavelength absorbed, complementary colour.</p> <p><b>3.1.2</b> Relation between colour and chemical constitution. (i) Armstrong theory (quinonoid theory) and its limitations (ii) Valence Bond theory; Comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones (iii) Molecular Orbital Theory.</p> <p><b>3.2. Non-textile Uses of Dyes</b> Structural features of the substrate, fastness and other property requirements and main classes of dyes used to be mentioned as applicable. (Two examples with structures for each of the following.) 1. Leather 2. Paper 3. Foodstuff 4. Cosmetics 5. Medicinal 6. Biological Stains 7.</p>	<p><b>(5L)</b></p> <p><b>(6L)</b></p> <p><b>(2L)</b></p> <p><b>(2L)</b></p>



		<p><b>vii.</b> Malachite Green by using benzaldehyde and N,N-dimethylaniline.</p> <p><b>viii.</b> Auramine O from dimethylaniline</p> <p><b>ix.</b> Methylene Blue by using 4-amino-N,N-dimethylaniline and N,N-dimethylaniline</p> <p><b>x.</b> Safranin T by using o-toluidine and aniline</p> <p><b>xi.</b> Pararosaniline by using p-toluidine and aniline</p> <p><b>xii.</b> Alizarine Cyanine Green G by using phthalic anhydride and p-chlorophenol</p> <p><b>xiii.</b> Indanthrene from anthraquinone</p> <p><b>xiv.</b> Disperse Yellow 6G from benzanthrone</p> <p><b>xv.</b> Indigo from aniline</p> <p><b>xvi.</b> Eosine by using phthalic anhydride and resorcinol</p> <p><b>xvii.</b> Bismark Brown from m-phenylenediamine.</p> <p><b>4.2 Types of Fibres and Classes of Dyes Applicable to them</b></p> <p>Introduction to the following types of fibres with structures and classes of dyes applicable to it. Cotton, Wool, Silk, Polyester.</p> <p><b>4.3 Ecology and Toxicity of Dyes</b></p> <p>With reference to the textile dyes, food colours, benzidine etc.</p>	(2L)
--	--	---	------

## Semester VI Practical

RUSACPDD601	Drugs & Dyes		Credits
	<b>Drug Preparation</b>		<b>02</b>
	1.	Preparation of Aspirin from Salicylic Acid	
	<b>Drug Estimation</b>		
	1.	Estimation of Tincture of Iodine	
	<b>Dye Preparation</b>		
	1.	Preparation of m-dinitrobenzene	
	2.	Preparation of m-nitroaniline	
	<b>Dye Estimation</b>		
	1.	Estimation of Methyl Orange/ Eriochrome Black T/Eosin/Congo Red by colorimetry	
	<b>Dyeing of fabric ( cotton )by Direct Dyeing or by Vat Dyeing.</b>		

### References:

1. Medical Chemistry by V K Ahluwalia, Madhu Chopra, Ane's Books Pvt. Ltd.
2. Organic Chemistry of Drug Discovery and Drug Design – Richard B. Silvermann
3. Medicinal Chemistry – Shreeram and Yogeshwari (Pearson)
4. Chemistry of dyes and principles of dyeing, Shenai V.A., Sevak publications, 1973



## MODALITY OF ASSESSMENT

### Theory Examination Pattern:

#### A) Internal Assessment 40%

**40 Marks**

Sr No	Evaluation type	Marks
1	One Assignment	10
2	One class Test (multiple choice questions / objective/ drawing structure of drugs and dyes)	20
3	Active participation in class	05
4	Overall conduct, participation in curricular and co-curricular activities.	05

#### B) External Examination – 60% (60 Marks)

##### Semester End Theory Examination-

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

iv. **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

Particulars	Marks
Journal	05
Experimental Work	30
Active Participation	05
<b>Total</b>	<b>40</b>

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

Sr.No.	Particulars	Marks
1)	Laboratory Work	25 +25
2)	Viva- Voce	05 + 05
	<b>Total</b>	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 Report, a Lost Certificate should be obtained from Head/ Coordinator / 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	RUSACDD601		Total
	Internal	External	
Theory	40	60	100
Practical's	40	60	100

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

**S.P. Mandali's**  
**Ramnarin Ruia Autonomous College**  
*(Affiliated to University of Mumbai)*



**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 2020-21)**

## 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
<b>A student completing Bachelor's Degree in Science program will be able to:</b>	
<b>PO 1</b>	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.
<b>PO 2</b>	Evaluate scientific ideas critically, analyse problems, explore options for practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.
<b>PO 3</b>	Explore and evaluate digital information and use it for knowledge upgradation. Apply relevant information so gathered for analysis and communication using appropriate digital tools.
<b>PO 4</b>	Ask relevant questions, understand scientific relevance, hypothesize a scientific problem, construct and execute a project plan and analyse results.
<b>PO 5</b>	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.
<b>PO 6</b>	Apply scientific information with sensitivity to values of different cultural groups. Disseminate scientific knowledge effectively for upliftment of the society.
<b>PO 7</b>	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.
<b>PO 8</b>	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
<b>A student completing Bachelor Degree in science program with applied component as NCE-WR will be able to:</b>	
<b>PSO 1</b>	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.
<b>PSO 2</b>	Devise suitable actions that are needed to reform the society to avert the environmental crisis ..
<b>PSO 3</b>	Develop the sense of rights and responsibilities towards the resources that support us.
<b>PSO 4</b>	Create awareness in self & the society that , solution to each and every problem begins with oneself .

## PROGRAM OUTLINE

<b>SEMESTER V</b>			
Course Code	Unit	Course Title / Unit Title	Credits
<b>RUSACNCE501</b>	<b>Non-Conventional Sources of Energy &amp; Waste Recycling</b>		<b>2</b>
	<b>I</b>	<b>NON-CONVENTIONAL SOURCES OF ENERGY:</b> Perspectives on Energy Sources and Utilization	
	<b>II</b>	Study of the following non-conventional energy sources with respect to scope, present scenario, applications, limitations and future prospects: <ul style="list-style-type: none"> <li>• Solar Energy</li> <li>• Wind Energy</li> <li>• Geothermal Energy:</li> </ul>	
	<b>III</b>	<b>WASTE RECYCLING:</b> Introduction to waste management. Management of gaseous waste	
	<b>IV</b>	Introduction to liquid waste Particulate matter and its management	
<b>RUSACNCEP501</b>	<b>Practical</b>		<b>2</b>

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

**SEMESTER V**  
**Course Code : RUSACNCE501**  
**Course Title : Non-Conventional Sources of Energy & Waste Recycling**  
**Academic year 2020-21**

**Course Outcomes:**

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

**DETAILED SYLLABUS**

<b>RUSACNCE501</b>	<b>Non-Conventional Sources of Energy &amp; Waste Recycling</b>		<b>Credits-02</b>
	<b>Unit</b>	<b>Unit Title</b>	<b>Lectures</b>
	<b>I</b>	<b>Perspectives on Energy Sources and Utilization:</b> <b>1.1.</b> 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. <b>1.2.</b> 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. <b>1.3.</b> Various types of energy sources, conventional/ non-conventional,	<b>(15L)</b>

	<p>renewable / non-renewable, fossil fuels: coal, oil, natural gas; thermal, hydroelectric and nuclear.</p> <p><b>1.4.</b> Energy storage and conservation methods. Role of government and Non-Governmental Organizations, socio-economic aspects, Government policies.</p> <p><b>1.5.</b> Fundamentals of energy efficiency, the energy efficiency gap, participants in the field of energy efficiency, Energy efficiency policies.</p> <p><b>1.6.</b> 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.</p> <p><b>1.7.</b> Entrepreneurship opportunities in the energy sector.</p>	
<b>II</b>	<p><b>Study of the following non-conventional energy sources with respect to scope, present scenario, applications, limitations and future prospects:</b></p> <p><b>2.1 Solar Energy</b></p> <p><b>2.1.1</b> 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.</p> <p><b>2.1.2</b> Photovoltaic effect, semi-conductors as solar energy converters, different materials used, factors affecting photovoltaic efficiency, effect of temperature, solar cells.</p> <p><b>2.1.3</b> Photo-electrochemical process for the conversion of solar energy; applications of solar energy for different purposes.</p> <p><b>2.2 Wind Energy</b></p> <p><b>2.2.1</b> Wind velocity and generation of wind energy</p> <p><b>2.2.2</b> Types of wind mills and their working, rotor with blades, gear generator, vertical and horizontal axis of rotation.</p> <p><b>2.3 Geothermal Energy:</b></p>	<p><b>(7L)</b></p> <p><b>(4L)</b></p> <p><b>(4L)</b></p>



	<p><b>2.3.1:</b> Origin of geothermal heat, temperature gradient, geothermal steam and hot spring, geysers.</p> <p><b>2.3.2:</b> Power production from geysers, mantle as heat source.</p>	
<b>III</b>	<p><b>WASTE RECYCLING:</b></p> <p><b>3.1 Introduction to waste management:</b></p> <p><b>3.1.1</b> 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.</p> <p><b>3.1.2</b> Waste disposal and its three 'R's Recovery, reuse, recycle and disposal of waste, economic viability of each of the above, waste audit.</p> <p><b>3.1.3</b> 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.</p> <p><b>3.2 Management of gaseous waste:</b></p> <p><b>3.2.1:</b> Generation of gaseous waste, smoke, fog mist, emission of gases, Sources, contribution of different sources to total waste. Effects: vehicular and chimney exhaust</p> <p><b>3.2.2</b> Treatment methods, adsorption, absorption, catalytic conversion, their feasibility cost and regulation</p> <p><b>3.2.3</b> Minimization methods, economic viability of reuse.</p>	<p><b>(9L)</b></p> <p><b>(6L)</b></p>
<b>IV</b>	<p><b>4.1 Introduction to liquid waste</b></p> <p><b>4.1.1:</b> Liquid Waste: Generation, local and global sources, variation in the amount generated.</p> <p><b>4.1.2</b> Characterization of liquid waste</p> <p><b>4.1.3</b> Physical parameters; colour, odour, turbidity, TSS, TDS, TS</p> <p><b>4.1.4</b> Chemical parameters: pH, acidity, alkalinity, hardness, DO, COD, TOC,</p>	<p><b>(8 L)</b></p> <p><b>(7 L)</b></p>

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

### 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
<b>Total</b>		<b>40 Marks</b>

#### 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
<b>Total</b>	<b>40</b>

**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
<b>Total</b>		<b>60</b>

**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:**

<b>After studying this course, the learner will be able to:</b>	
<b>CO 1</b>	Summarize the ocean-based non-conventional energy sources- namely OTEC and Tidal, and appraise them in keeping with the current local and global scenario.
<b>CO 2</b>	Explain the construction and working of fuel cells, and recognize their potential as the solution to the global energy crisis
<b>CO 3</b>	Explore the prospects of hydrogen as a fuel.
<b>CO 4</b>	Define biomass, describe the use of biomass as an energy source.
<b>CO 5</b>	Outline the use of biomass in India.
<b>CO 6</b>	Characterize the management of solid waste with respect to its sources, and disposal methods.
<b>CO 7</b>	Appreciate the significance of recycling, reuse & reclamation of solid waste.
<b>CO 8</b>	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.
<b>CO 9</b>	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	<p><b>Study of the following non-conventional energy sources</b></p> <p><b>1.1 Tidal Energy:</b></p> <p><b>1.1.1:</b> Tide height and its potential for power generation. (6L)</p> <p><b>1.1.2:</b> Construction of dam across sea basin, installation of the turbine, specification of the basin. (3L)</p> <p><b>1.2. Ocean Thermal Energy Conversion</b></p> <p><b>1.2.1</b> Difference in surface temperatures and at a depth in ocean, its use as a source for power generation (3L)</p> <p><b>1.2.2</b> Requirements for a practical OTEC plant, different working fluids.</p> <p><b>1.2.3</b> Relevance to the present scenario, feasibility and future projection.</p> <p><b>1.3. Fuel Cells:</b></p> <p><b>1.3.1</b> Electrochemical energy conversion, basic principle of fuel cells, advantages of energy conversion in fuel cells, distinction between fuel cell and battery.</p> <p><b>1.3.2</b> Hydrogen – oxygen fuel cell, organic oxygen fuel cell</p> <p><b>1.3.3</b> Applications of fuel cells.</p> <p><b>1.4 Use of hydrogen as a potential fuel:</b> availability, generation and use, feasibility and economic viability, advantages, Economically viable hydrogen production, photolysis of water.</p>	(3L)
	II	<p><b>Biomass:</b></p> <p><b>2.1</b> 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)</p>	(15L)

	<p><b>2.2</b> Biomass properties, types and energy value, utilization with and without conversion.</p> <p><b>2.3</b> Importance of lignin with respect to biomass energy, lignin content in various biomass, Non-lignocellulosic biomass (algae) and microalgae cultivation, macroalgae (seaweed) cultivation.</p> <p><b>2.5</b> Biomass processing methods: Physical, thermochemical (pyrolysis, torrefaction, gasification, trans-esterification), biochemical (anaerobic digestion, fermentation, enzymatic conversion).</p> <p><b>2.6</b> 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.</p>	
	<p><b>III WASTE RECYCLING:</b></p> <p><b>3.1 Solid Waste Management:</b></p> <p><b>3.1.1</b> Solid waste, sources and their characterization.</p> <p><b>3.1.2</b> Classification of solid waste: chemical nature, biodegradable and non biodegradable, their feasibility with respect to the use of three 'R's.</p> <p><b>3.1.3</b> 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.</p> <p><b>3.1.4:</b> Methods of disposal of solid waste:</p> <p><b>3.1.4.1</b> Dumping of garbage,</p> <p><b>3.1.4.2</b> Sanitary landfills,</p> <p><b>3.1.4.3</b> Composting, soil conditioning, vermi-composting.</p> <p><b>3.1.4.4</b> Incineration;</p> <p><b>3.1.5</b> Hazardous and toxic waste, definition, classification, difference between the hazardous and toxic waste, methods of minimization/</p>	(15L)

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



## 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. <b>Group Activities:</b>	
	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
<b>Total</b>		<b>40 Marks</b>

#### 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
<b>Total</b>	<b>40</b>

**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
<b>Total</b>		<b>60</b>

**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	601		Total
	Internal	External	
<b>Theory</b>	<b>40</b>	<b>60</b>	<b>100</b>
<b>Practicals</b>	<b>40</b>	<b>60</b>	<b>100</b>

**(Total Marks : 200)**