# **SYLLABUS**

## **B.Voc.** Renewable Energy Technology & Management (RETM)



Deendayal Upadhyay Kaushal Kendra (DDUKK) Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot (Accredited Grade A by NAAC)

S.N.	Name of the Course	Course	Credits	Hours	Remarks
		Code			
	1 <sup>st</sup> Semester				
	Skill Component				
1.	Basic Electrical Engineering	BVRES	4(3+1)	75	
		101			
2.	Energy Sources and Energy Scenario	BVRES	2(2+0)	30	
		102			
3.	Engineering Drawing	BVRES	3(0+3)	90	
		103			
4.	Workshop Practice	BVRES	3(0+3)	90	
5		104	( <b>0</b> , <b>4</b> )	100	Elective on non
э.	work Integrated Learning-I	BVRES	6(2+4)	180	Skill Level 4 of
		105			GISC
	Sub Total		18(5+13)	465	0.000
-	General Component		10(0.10)		
6.	Communication Hindi	BVREG	2(1+1)	45	Compulsory
•••		101	_()		y
7.	Fundamentals of Computer	BVREG	4(2+2)	90	Compulsory
	1	102	· · · ·		1 5
8.	General Subject Paper 1	BVREG	6(4+2)	120	Elective
	5 1	103			
	Sub Total		12(7+5)	255	
	Total of 1 <sup>st</sup> Semester		30(12+18)	720	
	2 <sup>nd</sup> Semester				
	Skill Component				
1.	Electronics & Instrumentation	BVRES	4(2+2)	90	
		106			
2.	Applied Physics	BVRES	3(2+1)	60	
		107			
3.	Basic Mechanical Engineering	BVRES	5(3+2)	105	
		108			
4.	Work Integrated Learning-II (WIL-II)	BVRES	6(2+4)	180	Elective as per
		109			Skill Level 4 of
	Sub Total		19(7,11)	135	0.30
	Sub Total Conoral Component		10(7+11)	433	
5	General Subject Paper-2	BVREG	$6(4 \pm 2)$	120	
5.	General Subject 1 aper-2	104	0(412)	120	
6	Communication English	BVRFG	2(1+1)	45	
0.		105	2(111)	-15	
7	Statistical Methods and Analysis	BVREG	2(1+1)	45	
/.	Sufficient Methods and Amarysis	106	2(111)	-15	
7	Values and Social Responsibilities(VSR)	BVREG	2(1+1)	45	
/.	values and social responsionnes(vorc)	107	2(111)	15	
-	Sub Total	107	12(7+5)	255	
	Total of 2 <sup>nd</sup> Semester		30(14+16)	690	
	Total of 1 <sup>st</sup> Year		60(26+34)	1410	
	3 <sup>rd</sup> Semester				
	Skill Component				
1.	Solar Photovoltaic Technology	BVRES	3(2+1)	60	
		201	, í		
2.	Waste to Energy Conversion System	BVRES	3(2+1)	60	

#### DETAILED CURRICULUM OF B.VOC. (RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT)

		202			
3.	Solar Thermal Energy Applications	BVRES 203	3(2+1)	60	
4.	Energy Conversion Systems-1 (Fluid Mechanics)	BVRES 204	3(2+1)	60	
5.	Work Integrated Learning-III	BVRES 205	6(2+4)	180	Elective as per Skill Level 5 of GJSC
	Sub Total		18(8+10)	420	
	General Component		- ( )		
5.	Computer Programming and Web Designing	BVREG 201	3(1+2)	75	
6.	Environmental Studies and Disaster Management	BVREG 202	3(2+1)	60	
7.	General Subject Paper III	BVREG 203	6(4+2)	120	
	Sub Total		12(7+5)	255	
	Total of 3 <sup>rd</sup> Semester		30(15+15)	675	
	4 <sup>th</sup> Semester				
	Skill Component				
1.	Wind Energy Conversion Systems	BVRES 206	4(3+1)	75	
2.	Biomass Energy Conversion System	BVRES 207	3(1+2)	75	
3.	Material Science	BVRES 208	3(2+1)	60	
4.	Energy in Buildings	BVRES 209	2(1+1)	45	
5.	Work Integrated Learning-4	BVRES 210	6(2+4)	180	Elective as per Skill Level 5 of GJSC
	Sub Total		18(7+11)	435	
	General Component				
6.	General Subject Paper IV	BVREG 204	6(4+2)	120	
7.	Accounting Practices and Tally	BVREG 205	4(2+2)	90	
8.	Values & Social Responsibilities	BVREG 206	2(1+1)	45	
	Sub Total		12(7+5)	255	
<b> </b>	Total of 4" Semester		30(14+16)	690 1275	
	1 Otal OI 2 Year		00(29+31)	1365	
-	5 Semester Skill Component				
	Energy Management and Auditing	BVRES 301	3(2+1)	60	
	Solar Power Plants	BVRES 302	4(3+1)	75	
	Elective -1	BVRES 303	5(3+2)	105	
	Work Integrated Learning	BVRES 304	6(2+4)	180	Elective as per Skill Level 6 of GJSC
<u> </u>	Sub Total		18(8+10)	420	
	General Component		- (		
	Reasoning and Analytical Ability	BVREG 301	2(1+1)	45	Compulsory Papers
	Paper - V of Chosen Subject	BVREG	6(4+2)	120	Electives of the

	302			chosen General
				stream
Entrepreneurship Development	BVREG	A(2+2)	90	
Entrepreneursnip Development	303	<b>H</b> (2+2)	70	
Sub Total		12(7+5)	255	
Total of 5 <sup>th</sup> Semester		30(15+15)	675	
6 <sup>th</sup> Semester				
Skill Component				
Other Renewable Energy Systems	BVRES	2(2+0)	30	
	305			
Energy Modelling and Project Management	BVRES	3(2+1)	60	
	306			
Elective-II	BVRES	5(3+2)	105	
	307	, ,		
Work Integrated Learning-VI	BVRES	6(2+4)	240	Elective as per
	308	•(= · · ·)		Skill Level 6 of
	500			GJSC
Sub Total		18(7+11)	435	
General Component				
Comments Social Decrementi lilita (CSD)	BVREG	$2(1 \cdot 1)$	45	
Corporate Social Responsibility (CSR)	304	2(1+1)	45	
Paper - VI of Chosen Subject	BVREG	6(4+2)	120	
	305			
Management Information System	BVREG	4(2+2)	90	
	306	~ /		
Sub Total		12(7+5)	255	
Total of 6 <sup>th</sup> Semester		30(14+16)	690	
Total of 3 <sup>rd</sup> Year		60(29+31)	1365	
Grand Total for the whole programme		180(84+96)	4140	
Electives				
Power Electronics		5(3+2)	105	
Bio Chemistry Renewable Energy Resources and		5(3+2)	105	
improved Utilisation				
Digital Electronics and Microprocessor		5(3+2)	105	
Smart and Micro grid		5(3+2)	105	
Energy storage system		5(3+2)	105	
Energy Economics and Planning		5(3+2)	105	
Energy Efficiency in Thermal Utilities		5(3+2)	105	
Energy Efficiency in Electrical Utilities		5(3+2)	105	
Hydrogen Energy and Fuel Cells		5(3+2)	105	
Spectroscopy		5(3+2)	105	
Students have to choose any two of the elect	ives mentio	ned above and	l take on	e elective each in 5 <sup>th</sup>
and 6 <sup>th</sup> semesters				

#### Weight age and Evaluation Criteria

0			
Theory/	CFA	ESE	Evaluation Criteria
Practical			
Theory	40%	60%	CFA : Attendance 25%, Class performance & Assignment 25%, Test and
			Viva 50% ESE : Test 60%
Practical	60%	40%	CFA & ESE : Practical and record 50%, Test 25%, Viva 25%

SEMESTER-I

VRTS 101: Basic Electrical Engineering 5(3+2)

### Basic Electrical Engineering (3+2)

#### UNIT -I

#### AC CIRCUITS

Review of I-phase as circuits under sinusoidal steady state. Active, reactive and apparent power, power factor. 3- Phase AC circuits, star and delta connections. 3- Phase source and load. Analysis of balanced and unbalanced systems. Power in 3 phase circuits and their measurements.

#### UNIT -II

#### MAGNETIC CIRCUITS

Review of laws of electromagnetism. Flux, e.m.f and their relation. Analysis of magnetic and electric circuits. Saturation, B-H curves, fringing and leakage. AC excitation in magnetic circuits. Induced voltage, Hysteresis effect and eddy currents.

#### UNIT -III

#### TRANSFORMERS

Single-phase transformer, Basic concepts and construction features. Types of transformers, Voltage, current and impedance transformation. Equivalent circuits. Per unit system, voltage regulation, losses and efficiency. Testing of transformers. Auto transformers.

#### UNIT -IV

#### ELECTRO MECHANICAL ENERGY CONVERSION

Principles of energy conversion. Production of force and e.m.f. Singly and multiply excited magnetic field system. Torque production and torque balance. General analysis of electromechanical System. **UNIT -V** 

#### UNIT-V

#### ROTATING ELECTRIC MACHINES

General construction. Definitions and terminologies, generation of e.m.f in rotating machines. Voltage in DC and AC machines. Air gap e.m.f in DC and AC machines. Rotating magnetic field. Torque production. Principle of operation and application of DC, 3- phase synchronous and induction machines. Single phase induction motors. Insulating materials, name plate rating, frame size, duty cycles, cooling, enclosures materials and standards.

#### PRACTICAL

Measurement of impedance of RL, RC and RLC circuits. Study of Resonance phenomenon

Measurement of active and reactive powers in I – phase and 3-phase

Study of no load current waveform in a single phase transformer using CRO

Study of transformer name plate rating, determination of ratio and polarity Determination of equivalent circuit parameters of a single phase transformer by O.C. and S.C. tests and estimation of voltage regulation and efficiency at various loading conditions. Verification by load test

Study of constructional features of DC machines. Magnetization and load characteristics of DC generator Characteristics of DC motors. Study of 3 and 4 point starters for DC shunt motors

- Speed control of DC motor by armature resistance control and field resistance control and armature voltage control
- Study of constructional features of K3- phase induction motors. No load, blocked rotor and load tests on 3 phase Induction motors

Starting methods and construction of Single phase Induction motors.

#### REFERENCES

Electrical Machinery, A.E. Fitzgerald, C. Kingsley and Umans, Mc Graw Hill, 5th Edition, 1992 Principles of Electrical Engineering, Vincent Del Toro, Prentice Hall, 1987

VRTS102	Energy Sources and Energy Scenario	4(3+1)
Init I .	Concept of France and Conventional France Sources	
	Introduction-Definition and units of energy and power, Conversion, Energy terms, calorific value, For Thermodynamics, Energy parameters, Role of energy in economic development and social transformation, I Conventional Energy Sources - Energy Sectors: Domestic, Transportation, Agriculture, Industry Sector sources, Quality and concentration of energy sources, Conventional Energy Sources - Coal, oil, gas, Origin of fossil fuels, Fuels, Classification of fuels, Solid fuels ,Liquid fuels, Gaseous fuels, Energy flow diagram	ms of energy, Energy and Energy security ; Classification of energy of fossil fuels, Time scale to the earth;
Unit II :	Introduction to Non-conventional and Renewable Energy sources- Solar energy-Solar Photovoltaic and solar energy around the globe and across the seasons; Wind energy/power-Motion and variation of wind pe and biogas, Ocean energy, Wave energy, Tidal energy/power, Geothermal energy, Hydrogen energy, Nucle power, Fuel cell;	Solar Thermal, variation of ower, Energy from biomass ar Energy, Thermo-electric
Unit III :	Energy and Growing Economy	
	Comparative study of Energy Sources: Comparison of various conventional and non conventional ener	gy systems, their prospects
	and limitations <b>Energy Production and distribution</b> . Electricity generation from different conventional and Non Conven	tional sources Commercial
	energy production and user building Electricity generation non-dimension conventional and ron conventionand and ron conventional and ron conventional and ro	eeds of growing economy,
	Energy Conservation-Energy conservation and its importance, Energy strategy for the future, Energy Confeatures	servation Act-2001 and its
Unit IV:	<b>Global Energy Scene:</b> Energy consumption in various sectors, projected energy consumption for the increase in energy consumption, energy resources, coal, oil, natural gas, nuclear power and hydroelectricity in energy consumption on global economy, future energy options.	next century, exponential , impact of exponential rise
Unit V:	Indian Energy Scene: Commercial and non-commercial forms of energy, energy consumption pattern and of time, India's Power Scene, Gas-Based Generating Plants, Nuclear Power Programme, urban and rural e as a factor limiting growth, need for use of new and renewable energy sources, Socioleconomic impacts, H alleviation, Employment; Security of supply and use, Environmental and ethical concerns, Economical as systems vs large hydro and thermal power projects.	l its variation as a function nergy consumption, energy Rural development, Poverty spects of renewable energy
Text Bool	xs:	
1.	Bani P. Banerjee, Energy and the Environment in India, Oxford University Press, New Delhi.	
2.	G. D. Rai, Non- conventional Sources of Energy, Khanna Publishers, Delhi.	
3.	Gopal kumar, Energy Independence Vision of a Hybrid, Unbound Future, Deep and Deep Publications Pvt.	Ltd., New Delhi.
4.	D. K. Asthana, Meera Asthana, Environment Problems and Solutions, S. Chand and Company Ltd., New De	elhi.
5.	Abdul Mubeen, M. Emran Knan, M. Muzaffarul Hasan, Energy and Environment, Anamaya Publishers, Ne	w Delni.
0. 7.	Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, PHI, New Delhi	Tabau
VRTS 103	Engineering Drawing	3(0+3)
Unit-1:	Introduction to equipments and accessories related to Engineering Drawing- Drawing Board- Sizes of table/board; Drawing Sheets- Sizes and layout of standard drawing sheets; Drawing instruments-Compass, I Different types of Lines and Free Hand Sketching, Different types of lines in engineering drawing Practice in free hand sketching of vertical, horizontal and inclined lines, Geometrical figures such as triar large engages and engage and engages a	f drawing boards; Drafting Divider, Pencils etc. as per BIS specifications, ngles, rectangles, small and
Unit-2:	<b>Lettering Techniques and Practice</b> - Instrumental single stroke (capital and inclined) lettering of 35 m 7:4,Instrumental double stroke lettering of 35 mm height in the ratio of 7:4, vertical ,Free hand lettering (all case and upper case, single stroke vertical and inclined at 75 degree in different standard series of 2.5, 3, 5, the ratio of 7:4	nm height in the ratios of bhabet and numerals) lower 7,10, and 15 mm heights in

**Dimensioning**: Necessity of dimensioning, terms and notations – methods and principles, dimensioning small components as below (mainly theoretical instructions), Dimensioning of overall sizes, circles, thread holes, chamfered surfaces, angles, tapered surface holes equally spaced on PCD, counter sunk hole counter bored holes, cylindrical parts, narrow space and gaps, radii, curves and arches – chain and parallel dimensioning

Unit-3: Scales : their need and importance, Definition of representative fraction (RF); Find RF of a given scale, Types of scales, Construction of plain and diagonal scales

Principle of Projections : Concept of planes, Projection of points situated in different quadrants, Concept of First angle and Third angle Projection,

Unit-4: Projection of lines: Lines parallel to both the planes, Lines perpendicular to one plane and parallel to other, inclined to one plane and parallel to the other and vice versa

Principle of orthographic projection: Drawing 3 orthographic views of given objects (at least five objects)

Unit-5: Civil Engineering Drawing: Understanding basic principles of sections, Different symbols used in drawing, Drawing three views of simple buildings, Understanding drawing for Electrical fittings and sanitary fittings, Knowledge about using building codes, Introduction of Simple Estimates particularly related to Sanitary and Electrical fittings

#### **RECOMMENDED BOOKS**

- 1. Elementary Engineering Drawing (in first angle projection) by ND Bhatt, Charotar Publishing House
- 2. A Text Book of Engineering Drawing by Surjit Singh published by Dhanpat Rai and Co., Delhi
- 3. Engineering Drawing by Laxminarayan

Students have to do practice in the following shops: 1. Carpentry shop

- 2. Fitting and plumbing shop 3. Welding shop
- 4. Paint shop

5. Forging and sheet metal shop

- 6. Electric shop
- 7. Electronics Shop

#### 1. Carpentry Shop

Introduction to various types of wood, carpentry tools - their identification with sketches.Different types of wood joints; Simple operations viz. hand sawing, marking, planing; Introduction and sharpening of wood working tools and practice of proper adjustment of tools ; Demonstration and use of wood working machines i.e. hand saw, circular saw, rip saw, bow saw and trammels. Universal wood working machine and wood turning lathe;

Jobs :Making of various joints (Also draw the sketches of various wooden joints in the Practical Note Book)

a) Cross lap joint b) T-lap joint c) Corner lap joint d) Mortise and tenon joint e) Dovetail joint f) Prepare a file handle or any utility items by wood turning lathe

#### 2. Fitting and Plumbing Shop

Introduction to fitting shop, common materials used in fitting shop, description and demonstration of various types of work-holding devices and surface plate, V-block; Demonstration and use of simple operation of hack-sawing, demonstration of various types of blades and their uses; Demonstrate and use of all important fitting shop tools with the help of neat sketches (files, punch, hammer, scraper, taps and dyes etc.); Introduction of chipping, demonstration on chipping and its applications. Demonstration and function of chipping tools; Description, demonstration and practice of simple operation of hack saw, straight and angular cutting; Demonstrations, description and use of various types of blades - their uses and method of fitting the blade; Introduction and use of measuring tools used in fitting shop like: Try square, Steel rule, Measuring Tape, Outside micrometer, Vernier Calipers and Vernier Height Gauge; Description, demonstration and practice of thread cutting using taps and dies; Descriptions and drawing of various plumbing shop tools, Safety precautions; Introduction and demonstration of pipe dies, Pipe holding devices, Demonstration and practice of Pipe Fittings such as Sockets, Elbow, Tee, Reducer, Nipple, Union coupling, plug, Bend, Float valves and Taps

Jobs: Cutting and filing practice on a square of 45 X 45 mm2 from MS flat, Angular cutting practice of 450 (on the above job), Preparation of stud (to cut external threads) with the help of dies (mm or BSW), Drilling, counter drilling and internal thread cutting with Taps, H-Fitting in Mild steel (ms) square, Pipe cutting practice and thread cutting on GI Pipe with pipe dies

#### 3. Welding Shop

Introduction to welding, type of welding, common materials that can be welded; introduction to gas welding equipment, types of flame, adjustment of flame, applications of gas welding; Welding tools and safety precautions;

Introduction to electric arc welding (AC and DC), practice in setting current and voltage for striking proper arc, precautions while using electric arc welding, Applications of arc welding; Introduction to polarity and their use

Introduction to brazing process, filler material and fluxes; applications of brazing, Use of solder; Introduction of soldering materials ; Demonstrate and use of the different tools used in the welding shop with sketches. Hand shield, helmet, clipping hammer, gloves, welding lead, connectors, apron, goggles etc.; Demonstration of welding defects and Various types of joints and end preparation

Jobs: Preparation of cap joint by arc welding, Preparation of Tee joint by arc welding, Preparation of single V or double V butt joint by using Electric arc welding, Brazing Practice. Use of Speltor (on MS sheet pieces), Gas welding practice on worn-out and broken parts

#### 4. Paint Shop

Introduction of painting shop and necessity; Different types of paints, Introduction of powder coating paint and their uses.

Jobs: Preparation of surface before painting such as cleaning, sanding, putty, procedure and application of primer coat, and painting steel item, Painting practice by brush on MS sheet, Practice of dip painting, Practice of lettering: Name plates / Sign board, Polishing and painting on wooden and metallic surfaces, Practical demonstration of powder coating

#### 5. Forging and sheet metal shop

Introduction to forging, forging tools, tongs, blowers/pressure blowers, hammers, chisels, punch, anvil, swag-block etc.; Forging operations,

Jobs :Forge a L hook or Ring from MS rod 6 mm  $\varphi$ , Forge a chisel and give an idea of hardening and tempering, Lap joint with forge welding, High Strength Steel (HSS) tools - forging of Lathe shaper tools like side-tools and V-shape tools, Making sheet metal joints, Making sheet metal trey or a funnel or a computer chassis, Preparation of sheet metal jobs involving rolling, shearing, creasing, bending and cornering, Prepare a lap riveted joint of sheet metal pieces

#### 6. Electric Shop

Demonstration of tools commonly used in Electric Shop, Safety precautions, electric shock treatment, Demonstration of Common Electric material like: wires, fuses, ceiling roses, battens, cleats and allied items, Demonstration of Voltmeter, Ammeter, Multimeter and Energy meter Jobs: Wiring practice in batten wiring, plastic casing-capping and conduit; Control of one lamp by one switch; Control of one lamp by two switches; Control of one bell by one switch; Assemble a Tube light; Dismantle, study, find out fault, repair the fault, assemble and test domestic

appliances like electric iron, electric mixer, ceiling and table fan, tube-light, water heater (geyser) and desert cooler; Laying out of complete wiring of a house (Single-phase and Three-phase)

#### 7. Electronics Shop

Identification, familiarization, demonstration and use of the following electronic instruments:

a) Multi-meter digital b) Single beam simple CRO, function of every knob on the front panel c) Power supply, fixed voltage and variable voltage, single output as well as dual output.

Identification, familiarization and uses of commonly used tools; active and passive components; colour code and types of resistor and potentiometers; Cut, strip, join and insulate two lengths of wires/cables (repeat with different types of cables/ wires); Demonstrate and practice the skill to remove components/wires by unsoldering; Cut, bend, tin component, leads, inserts. Solder components e.g. resistor, capacitor, diodes, transistors on a PCB; Wiring of a small circuit on a PCB/tag strip involving laying, sleeving and use of identifier tags; Demonstrate the joining (or connecting) methods/mounting and dismantling method, as well as uses of the items mentioned below:

a) Various types of plugs, sockets, connectors suitable for general-purpose audio video use. Some of such connectors e.g. 2 and 3 pin mains plug and sockets, Banana plugs, sockets and similar male and female connectors and terminal strips.

b) Various types of switches such as: normal/miniature toggle, slide, push button piano key, rotary, SPST, SPDT, DPST, DPDT, band selector, multi-way Master Mains Switch.

Exposure to modern soldering and de-soldering processes (Field visits); De-solder pump, remove and clean all the components and wires from a given equipment, a PCB or a tag strip.

A student has to choose any course approved by GJSC( Green job skill council ) for level 4. Some of the suggested courses are .....Students have to practice in various labs and workshops, undertake industrial visits

VRTG106	COMMUNICATION HINDI	2(1+1)

#### II) kf∪rd

- bdkb 11 संप्रेषण— अर्थ व महत्व, प्रभावी संप्रेशण के आव यक तत्व, संप्रेशण के तरीके—बोलकर, लिखकर, चित्र व अन्य माध्यम, पत्र लेखन, पत्रों के विभिन्न प्रकार, औपचारिक व अनौपचारिक पत्र, कार्यालयीन व व्यापारिक पत्र,भाासकीय व अर्द्धशासकीय पत्र
- bdkb 21 व्याकरण में कारक का महत्व, वाक्य संयोजन, वाक्यों के प्रकार, वाक्यों की सामान्य अशुद्धियां
- bdkb 3% मुहावरे व कहावतें, प्रत्यय व उपसर्ग का प्रयोग, समानार्थक व भिन्नार्थक भाब्द, कई शब्दों के बदले एक शब्द
- bdkb 4 सारांश लेखन, निबन्ध लेखन
- bdkb 5% विशिष्ट अवसरों के लिए लेखन– नारा लेखन, कविता, नाटक, संवाद) लेखन, चित्रों की व्याख्या

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VRTG107

- 1. संवाद अदायगी
- भाषण 2.
- बॉयोडाटा लेखन 3.
- 4 साक्षात्कार
- 5. सोशल मीडिया व सूचना प्रौद्योगिकी का प्रयोग
- समूह चर्चा
- 7. चित्र देखकर कहानी लिखना
- विशिष्ट अवसरों के लिए नारा लेखन 8.
- अपने उत्पाद की बिकी बढाने के लिए प्रभावी विज्ञापन बनाना 9
- 10. सेमिनार प्रस्तुति

#### FUNDAMENTALS OF COMPUTER 4(2+2)

- UNIT I: Introduction: Characteristics of Computers, Evolution of computers, Capabilities and limitations of computers, Generations of computers, Types of computers (micro, mini, main frame, supercomputers), Block diagram of computer, Basic components of a computer system-Input unit, output unit, Arithmetic logic Unit, Control unit, Central Processing Unit, Instruction set, processor speed, type of processors, Flowchart & algorithms and their applications
- UNIT 2 : Memory- main memory organization, main memory capacity, Types of RAM & ROM, cache memory, Secondary Storage Devices: Magnetic Tape, Magnetic Disks-Hard Disk, Floppy Disks, Optical Disks: CD, VCD, CD-R, CD-RW, DVD, Blue ray etc. Solid State Storage: Flash Memory: Different types of Pen drives & SD cards, USB Drives, PCs specifications and technological revolutions
- UNIT 3: Input devices: different types of Keyboards, Pointing Devices- different types of mouse, Touch Screens, Joystick, Electronic pen, Trackball, Scanning Devices-Optical Scanners, OCR, OMR, Bar Code Readers, MICR, Digitizer, Electronic card reader, Image Capturing Devices-Digital Cameras. Output devices: Monitors, CRT/LCD/TFT, Printers, Dot matrix, Inkjet, Laser, Plotters, Drum, Flatbed, Screen image projector, ATMs
- UNIT 4: Computer Software Software's its Need, Different types of software System software, Application software, System softwareoperating system, utility program, Introduction to operation system for PCs-DOS, windows, Linux, file allocation table (FAT & FAT32), files & directory structure and its naming rules.
- UNIT 5 : Programming languages - Machine, Assembly & high level Languages, 4GL, Merits and demerits of different computer languages, assemblers, compilers and interpreter, Application software and its types, Word-processing, Spreadsheet, Presentation graphics, Uses and examples and Area of application of each of them, Computer security, File security, Virus working, feature, types of viruses, virus detection, prevention and cure.

#### Practicals:

- 1. Given a PC, name its various components and list their functions
- 2. Identification of various parts of a computer and peripherals
- 3. Practice in installing a computer system by giving connection and loading the system software and application software
- 4. Installation of DOS and simple exercises on TYPE, REN, DEL, CD, MD, COPY, TREE, BACKUP commands
- 5. Exercises on entering text and data (Typing Practice)
- 6. Installation of Windows 98 or 2000 etc.
- (1) Features of Windows as an operating system
- Start
- Shutdown and restore
- Creating and operating on the icons
- Opening closing and sizing the windows
- Using elementary job commands like creating, saving, modifying, renaming, finding and deleting a file
- Creating and operating on a folder
- Changing setting like, date, time color (back ground and fore ground)
- Using short cuts
- Using on line help 7. MS-WORD

<sup>-</sup> File Management:

Opening, creating and saving a document, locating files, copying contents in some different file(s), protecting files, Giving password protection for a file

- Page Set up: Setting margins, tab setting, ruler, indenting

- Editing a document: Entering text, Cut, copy, paste using tool- bars

- Formatting a document: Using different fonts, changing font size and colour, changing the appearance through bold/ italic/ underlined, highlighting a text, changing case, using subscript and superscript, using different underline methods
- Aligning of text in a document, justification of document ,Inserting bullets and numbering
- Formatting paragraph, inserting page breaks and column breaks
- Use of headers, footers: Inserting footnote, end note, use of comments
- Inserting date, time, special symbols, importing graphic images, drawing tools

- Tables and Borders: Creating a table, formatting cells, use of different border styles, shading in tables, merging of cells, partition of cells, inserting and deleting a row in a table

- Print preview, zoom, page set up, printing options

- Using Find, Replace options
- Using Tools like: Spell checker, help, use of macros, mail merge, thesaurus word content and statistics, printing envelops and lables
- Using shapes and drawing toolbar,
- Working with more than one window in MS Word,
- How to change the version of the document from one window OS to another
- Conversion between different text editors, software and MS word
- 8. MS-EXCEL

- Starting excel, open worksheet, enter, edit, data, formulas to calculate values, format data, create chart, printing chart, save worksheet, switching from another spread sheet

- Menu commands: create, format charts, organise, manage data, solving problem by analyzing data, exchange with other applications. Programming with MS-Excel, getting information while working

- Work books: Managing workbooks (create, open, close, save), working in work books, selecting the cells, choosing commands, data entry techniques, formula creation and links, controlling calculations, working with arrays

- Editing a worksheet, copying, moving cells, pasting, inserting, deletion cells, rows, columns, find and replace text, numbers of cells, formatting worksheet

- Creating a chart:

Working with chart types, changing data in chart, formatting a chart, use chart to analyze data

- Using a list to organize data, sorting and filtering data in list
- Retrieve data with MS query: Create a pivot table, customising a pivot table. Statistical analysis of data
- Customize MS-Excel:

How to change view of worksheet, outlining a worksheet, customise workspace, using templates to create default workbooks, protecting work book

- Exchange data with other application: linking and embedding, embedding objects, linking to other applications, import, export document.

9. Internet and its Applications

- a) Log-in to internet
- b) Navigation for information seeking on internet

c) Browsing and down loading of information from internet

d) Sending and receiving e-mail

- Creating a message, Creating an address book, Attaching a file with e-mail message, Receiving a message, Deleting a message

10. Making Presentation using MS-PowerPoint : Applications of Power Point, Add Text and other Objects to Slides, Templates and Master Slides, Giving Animation effects, Links and Action buttons, Tuning up of Presentation,

11. Introduction to MS-Access: Understanding Databases, Creating Databases, Creating Tables, Adding, Editing and Viewing Data, Sorting, Query, Creating Forms, Creating Reports, Industrial application of MS-Excel & MS-Access, Creating tables in MS Access using different ways. Import and export data from MS Access' Creating queries in MS Access, Creating forms in MS Access

#### **RECOMMENDED READINGS:**

- Fundamental of Computer by P. K. Sinha BPB Publication, New Delhi
- Fundamentals of Computer by V Rajaraman; Prentice Hall of India Pvt. Ltd., New Delhi
- Computers Today by SK Basandara, Galgotia publication Pvt ltd. Daryaganj, New Delhi
- MS-Office 2000 for Everyone by Sanjay Saxena; Vikas Publishing House Pvt. Ltd., New Delhi
- Internet for Every One by Alexis Leon and Mathews Leon; Vikas Publishing House Pvt.Ltd., Jungpura, New Delhi
- A First Course in Computer by Sanjay Saxena; Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi
- Mastering Windows 95, BPB Publication, New Delhi
- Fundamentals of Information Technology by Leon and Leon; Vikas Publishing House Pvt.Ltd., Jungpura, New Delhi

#### SEMESTER-II

VRTS 201	1 Fundamentals of Electronics and Instrumentation	4(2+2)
Unit – I:	Fundamentals of Electronics -Introduction, Current and Voltage Source, Ohm's Law, Resistance, Combination in	series and parallel
	Conductors and insulators- Various materials and their use. Structure of Atom-Energy band gap diagram of Con	ductors. Physics of

- Conductors and insulators- Various materials and their use, Structure of Atom-Energy band gap diagram of Conductors. Physics of Semiconductor- Materials, Types of semiconductors P & N Types charge carriers –P & N junction theory-VI characteristics –ideal diode-Rectifiers-types of rectifiers- Filters-C, LC and  $\pi$  Regulators Zener diode -voltage Regulator, Series voltage Regulator Different types of filters- clipping and clamping circuits –LED-7-segment –Photo diode-LDR
- Unit II: Transistor: Definition, amplifying action, transistor configuration:-CB, CE, CC Configurations-comparison-thermal runway-heat sink-Transistor ratings -Transistor biasing and stabilization –selection of operating point-different biasing circuits. FET – introduction, Types, construction, operation, characteristics – FET Parameters–Comparison between FET and BJT– JFET, MOSFET – UJT Characteristics, features and Applications. Storage Batteries -Introduction, Types of Batteries Primary and Secondary Batteries-Classification of Secondary. Batteries base on their Use-Classification of Lead Storage Batteries Battery life and DOD, Battery Charging, State of Charge, Effect of temperature, Battery for Photovoltaic applications, Battery aging, important guidelines
- Unit III: Performance Characteristics of Instrument- Need of measurement, Classification of electronic instruments, Selection of Instruments, Static characteristics: Accuracy, Resolution, Precision, Expected value. Instruments: Solar radiation Measurement; Lux Meter, Pyrheliometer, Pyranometer, Sunshine Recorder, wind speed measurement aneamometer, Temperature measurement, Pressure, velocity and flow measurement, Heat flux measurement.
- Unit IV: Transducers: Principles and classification of transducers, basic requirements of transducers, displacement, strain gauge, LVDT & RVDT, potentiometer, capacitive & inductive, Temperature Transducer Resistance Temperature Detector (RTD), Thermistor, Thermocouple, Piezo-electric transducer, Optical Transducer- Photo emissive, Photo conductive, Photo voltaic, Photo-diode, Photo Transistor. Feedback Amplifiers: Classification: Feedback concept; Ideal Feedback amplifier: Properties of Negative Feedback Amplifier Topologies: Method of Analysis of Feedback amplifiers: Voltage series Feedback: Voltage series Feedback pair: Current series, Current shunt and Voltage shunt feedback; Effect of feedback on amplifier Bandwidth and stability.
- Unit V: Operational Amplifier: Idea of operational amplifier (OPAMP), Ideal OPAMP as black box, input and output impedance, OPAMP circuits as buffer, inverting and non-inverting amplifiers, adder and subtractor. Signal Generators & Conditioners: Square Wave Generator, Triangular Wave Generator, Sawtooth Wave generator, Differentiator & Integrator.

#### PRACTICALS

- 1. Study of forward and reversed biased characteristics of PN Junction Diode
- 2. Study of breakdown characteristics and voltage regulation action of Zener diode.
- 3. Study of half wave & full wave rectifier
- 4. To study and observe waveform at the output of half wave rectifier with and without filter capacitor. To measure DC voltage, DC current, ripple factor with and without filter capacitor.
- 5. Study of Capacitor input, L section and  $\pi$  section filter
- 6. Study of output characteristics of Bipolar Junction Transistor in CE mode.
- 7. Study of output and transfer characteristics JFET/ MOSFET.
- 8. Study of I-V characteristics of UJT and UJT based relaxation oscillator.
- 9. Study of I-V characteristics of SCR.
- 10. Design, build and test Low pass and High pass RC filters.
- 11. Study of Low voltage Half wave, Full wave and Bridge rectifier circuits.
- 12. Study of switching and amplification actions of BJT and JFET/ MOSFET
- 13. Study of potential divider biasing of BJT and its use in DC motor driving.

#### References

- 1. A Course in Electrical and Electronic Measurements and Instrumentation, A. K Sawhney, Dhanpat Rai & Co.
- 2. Electronic Instrumentation& Measurement by WilliamD Cooper & Albert C.Helfric, PHI Pub.
- 3. Instrumentation, Measurement & Analysis by K.K. Chaudhury & R.C.Nakra, TMH.
- 4. OP-AMP and linear integrated circuits 2nd edition, PLHI by Ramakant A. Gayakwad.
- 5. Integrated Electronics by Millman & Halkias, TMH Publishing Co.
- 6. Electronic Instrumentation, H S Kalsi, Tata McGraw-Hill Education.
- 7. Instrumentation Devices and Systems, C.S. Rangan, Tata McGraw-Hill Education.
- 8. Basic Electronics and Linear Circuits, Bhargava, Kurukshetra & Gupta Tata McGraw-Hill Publishing Ltd. 2007
- 9. Applied Electronics, R S Sedha, S. Chand and Company Ltd. 2008
- 10. Principles of Electronics, V.K. Mehta, S.Chand and Company Ltd.2005
- 11. Electronics Service Technology Vol-1. Saji A.G,Shyam Mohan , Ayodhya publications
- 12. Integrated Electronics, Jacob Millman and C. Halkias Mill, Tata McGraw-Hill Publishing Ltd
- 13. Science & Technology of Photovoltaics P Jayrama Reddy, BS Publications , CRC Press
- 14.Solar Electricity Handbook 2012 Edition: A Simple Practical Guide to Solar Energy- Designing and Installing Photovoltaic Solar Electric Systems, Michael Boxwell, Greenstream Publishers
- 14. Photovoltaics: Design and Installation Manual, Solar Energy International
- 15. Solar Electric Handbook: Photovoltaic Fundamentals and Applications, Solar Energy International

#### Text Books:

- 1. Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHI School Books
- 2. Fundamentals of Renewable Energy Systems Paperback D. Mukherjee, New Age International Publisher; First edition
- 3. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals PHI; 2 edition
- 4. G. D. Rai, Non- conventional Sources of Energy, Khanna Publishers, Delhi.

VRTS202	Applied Physics	4(3+1)
Unit – 1:	Electrostatics: Static electricity-Absolute and Relative Permittivity of a Medium-Laws of Electrostatics-E Induction-Electric Flux and Faraday Tubes-Electric Flux Density - Electric Displacement D-Gauss Law- Pois	lectric Field-Electrostatic sson and Laplace-Electric
	Potential and Energy-Potential and Potential Difference-Potential at a Point-Potential of a charged sphere	-Equi potential Surfaces-
	Voltage and Dielectric Strength-Boundary Conditions	
Unit – 2:	Electromagnetic Induction: Relation between Magnetism and Electricity-Production of Induced E.M.F. and C Electromagnetic Induction- Lenz's Law Induced E.M.FDynamically-Statically-induced E.M.FSelf-Induc	urrent-Faraday's Laws of tance-Coefficient of Self
	Inductance (L)-Mutual Inductance-Coefficient of Mutual Inductance (M)-Coefficient of Coupling-Inductance	es in Series and Parallel,
	Magnetic Hysteresis, Steinmetz Hysteresis Law-Energy Stored in Magnetic Field-Rate of Change of Stored E	nergy
Unit -3:	Electric Current and Ohm's Law: Electron Drift Velocity-Charge Velocity and Velocity of Field Propaga	tion- Electric Potential -
	Conductance and Conductivity- Ohm's Law Resistance in Series and Parallel- Equivalent Resistance-Relativ discharge of a capacitor through resistance. Colour code of resistance. Measurement of low and high current.	ve Potential-, Charge and voltage and resistance
Unit – 4:	Types of Resistors-Nonlinear – Varistor	
Unit -5:	Circuits-Short and Open Circuits- Series Circuit- Voltage Divider Circuits	
Reference	25	
1.	Electrical Technology, Naidu-Kamakshaiah, Tata McGraw-Hill Education	
2.	Fundamentals of Electrical Engineering, Rajendra Prasad, PHI Learning Pvt. Ltd.	
3.	A Text Book of Electrical Technology, B.L. Theraja, S. Chand Limited	
4	Photovoltaics: Design and Installation Manual Solar Energy International	

llation Manual, Solar

**VRTS 203** BASIC MECHANICAL ENGINEERING 4(3+1)

## B.Tech. (Agricultural Enginnering) II Sem Sub: Basic Mechanical Engineering 4 (3+1)

#### UNIT-I

#### WORKSHOP TECHNOLOGY:

Materials of Construction. Classification of Engineering materials, Composition, Mechanical properties and uses of cast iron, mild steel, high carbon steel and high speed steel. Foundry Practice: Introduction, Pattern, Pattern materials like wood, metals, plastics etc. Types of pattern like solid, split, match plate, gated and sweep, pattern allowances, Mould materials, Properties of a good molding sand. Composition of green sand, dry sand, loam sand. Types of mould gating system. Core, Core materials, properties of good core materials, core preparation.

#### UNIT -II

#### WELDING PRACTICE:

Gas Welding Method of preparation and accumulation of oxygen and acetylene. Equipment's used in high pressure and low pressure gas welding plant. Function of flux. Types of gas flames

Arc welding various methods of producing are Ate welding equipment's comparison between AC and DC welding ARC welding electrodes. Flux coating on welding electrodes.

#### UNIT-III

#### **MEASUREMENT, MEASURING TOOLS AND MACHINE TOOLS:**

Construction, care & uses of surface plate, Straight edge, Vernier calliper, Micrometer, Dial gauge, Slip gauge, Sine bar and Combination set. Description, definition, specification of machine tools, working, classification and specification of Lathe and drilling machine.

#### **UNIT-IV**

#### HEAT ENGINES:

#### Boilers

Names and functions of principle parts, classification, Boiler mountings and accessories, Draught-natural and artificial, Height of chimney, Equivalent evaporation and boiler performance. Steam Sensible heat, latent heat, super heat, internal energy, enthalpy, dryness fraction and its determination, steam processes at constant pressure, constant volume, and constant enthalpy.

#### UNIT-V

#### STEAM ENGINES

Description and working, hypothetical and actual indicator diagram, diagram factor, H.P. developed and efficiencies e.g. mechanical efficiency, brake thermal efficiency and indicated Thermal efficiency, governing, cut off and throttles compound engines (Description and working only).

#### I.C. ENGINES

Description and working of four stroke petrol engines, two stroke petrol engines, four stroke diesel engines and two stroke diesel engines, relative merits and demerits

#### Practical:

- To study foundry shop
- To study dial gauge
- To study Combination set
- To study gas welding
- To study lathe machine
- To study drilling machine
- To study boiler and its mountings and accessories
- To study IC engines and its system
- To perform spark test
- To perform sieve analysis

#### **References:**

- 1.Workshop practice Raghuvanshi
- 2. Workshop practice Hazra & chaudhary
- 3 Foundary Technology Sinha & Goel (Rastogi Publication)
- 4. Heat engines P.L. Sallaney
- 5. Heat engineering Kumar & Vasandani (Metropolitan Book Company)

#### VRTS 204

#### WORK INTEGRATED LEARNING-II

6(0+6)

A student has to choose any course approved by GJSC( Green job skill council ) for level 5. Some of the suggested courses are

VRTS 206	COMMUICATION ENGLISH	2 (1 + 1)

THEORY

- **UNIT-I:** Introduction to Communication : Communication its meaning and its importance, Type of communication oral, written and non verbal, Mode of Communication- Monologue, Dialogue, Group discussion, Essentials of good Communication- Effective communication, Miscommunication. English phonology, Intonation patterns in English, Intra-personal, Inter-personal and Group communication
- UNIT-II: Current Usage of English Grammar: Spotting the errors pertaining to Nouns, Pronouns, Adjective and Adverbs, Concord (Grammatical Concord, National Concord) and the Principal of Proximity between Subject and Verb, Correct use of Tense, Precis writing
- UNIT-III : Vocabulary : Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Phrasal Verbs, Changing the Voice: from Active to Passive and vice-versa, Lexis- Idioms and phrases: Words Often Confused, One-word Substitutes, Formation of Words (Suffixes, Prefixes and Derivatives), Collocations
- Unit-IV: Written Business Communication : Business Communication, Different forms of letter writing Formal and Informal letters, Official Letters, Business Letters, Memo, Notes, Tender Notice, Email Etiquette, Professional Presentations, Writing Skills, Documenting, Report Writing, Making notes, Letter writing, Writing a Resume, Writing- Memo and Note, Cover Letter
- **UNIT-V: Introduction to principal components of spoken :** Transcription, Word-Accent, Intonation, Weak Forms in English, Developing Reading and Writing Skills through tasks/ activities as Developing Outlines, Key Expressions, Situation, Slogan Writing and Theme Building Exercises, Dialogue Writing, Interpreting Pictures/Cartoons

#### PRACTICALS

- 1. How to locate reading material in the library
- 2. How to look up words in a dictionary

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- 3. How to look up information from an encyclopedia
- 4. Acquaintance with 44 sounds of pronunciation
- 5. Developing, Listening, Speaking and communicating Skills through Various activities such as
  - Introducing self and others

- Role play Activities .
- Practicing Short Dialogues
- Debates
- Speeches
- Group Discussion
- Telephonic Conversation
- Paper reading
- Listening to News Bulletins
- Viewing and Reviewing of TV Programmes
- Mock Interview
- Resume writing
- Seminar presentation on a given topic/theme
- Using IT and Social media Profile generation, Blog Writing Story writing by seeing picture
- 7.
- 8. Cartoons
- 9. Advertisement- effective use use of jingles

#### REFERENCES

6.

#### **Recommended Readings:**

- 1. Fluency in English Part II, Oxford University Press, 2006.
- 2. Business English, Pearson, 2008.
- Language, Literature and Creativity, Orient Blackswan, 2013. 3.
- LALA, PUSHP and Sanjay Kumar. 'Communicate or collapse: a handbook of effective public speaking, group discussions and interviews'. PHI Learning Pvt. Ltd., 2007. 4.
- 5. H.M.Prasad, 'How to prepare for Group Discussion and Interview'. Tata McGrawHill,
- R.S. Aggarwal, 'A Modern Approach to Verbal & Non-Verbal Reasoning', S. Chand & Co, 6.
- Aysha Viswamohan, "English for Technical Communication", Tata Mc-Graw Hill 7.
- Publishing Company Ltd., New Delhi 1.
- E.Suresh Kumar and P. Sreehari, "A Handbook for English Language Laboratories", Osmania University, Hyderabad, 2011 8. 2.

Semester-III	[
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VRTS301	Solar Photovoltaic Technologies	5(3+2)
Unit-1 :	<b>Basics of Solar Radiation:</b> Different types of Renewable Energy Sources, Sun as an ultimate source of Declination Angle, Hour Angle, Inclination Angle (Altitude), Zenith Angle, Solar Azimuth Angle, Azimuth Angle, Angle of Incidence, Local Solar Time. Solar Radiation, Extra Terrestrial at Earth's Surface, Estimation of Radiation, Alternation of Solar Radiation by Atmosphere, Effect of Orientation Spectrum, Extraterrestrial Radiation, Radiation on the Earth Surface, Global, Direct and Diffuse Solar R Given Location, Estimation of Monthly Average, Daily Total and Diffuse Radiation on Horizontal	of energy, Angle of Latitude Tilt Angle (Slope), Surface Surface – Horizontal, Tiltec of Receiving Surface, Solar adiation, Solar Radiation at a and Tilted Surface, Annua
Unit-2:	Variation in Solar Radiation, Optimal Tilt for Solar Equipment, Monthly Averaged Global Radiation at O <b>Fundamentals of Solar Cells:</b> Characteristics of semiconductors, Differences between semiconductor Theory of p n junction, Principle of operation of p-n junction Solar Cell, I-V Characteristics Solar C conversion efficience and power output of colar cell. Protection of Solar Cells	ptimal Tilt rs, insulators and conductors ell parameters ,Voc, Isc, FF
Unit-3:	Solar Photovoltaic Technologies: Solar PV Technology: Advantages and Limitations, Brief History of Technology Status of Photovoltaic Technologies, The Amount of Power Generated, The Rated Power	of the Technology, Basics of er and Actual Power from a
Unit 4:	Module, Generating More Power Using Solar PV, Solar PV Systems and their applications : Solar PV Module Ratings and Cost, Battery Ratings and Cos Maximum Power Point Tracking (MPPT), Solar PV Lantern, Design and Costing, Stand-alone PV Syste Usage, Solar PV System Designing, Case Study, Cost Estimation of a PV System	st , Inverter Ratings and Cost m: Home Lighting and Other
Practical		
1.	Identifying and Measuring the Parameters of Solar PV Module in the Field	
2.	Series and Parallel Connection of PV Modules	
3.	Estimating the Effect of sun Tracking on Energy Generation by Solar PV Modules	
4.	Efficiency Measurement of Standalone Solar PV System	
5.	Dark and Illumination Current-Voltage Characteristics of Solar Cell	
6.	Solar Cells Connected in series and in Parallel	
7.	Dependence of Solar Cell I-V Characteristics on Light Intensity and Temperature	
8.	Carrier Lifetime Measurements for a Solar Cell	
9.	Spectral Response Measurement	
10.	Solar Cell Simulation Using PC1D Simulator	
11.	SEQUEL: Using the GUI	
12.	Find the MPP manually by varying the resistive load across PV panel	
13.	Find the MPP by varying the duty cycle of the DC-DC converter	
14.	Observe the Vm, Im, Pm and duty cycle at which MPP occurs, with MPP algorithm	
15.	Observe the response of Pm in the Plotter and compare with the Pm observed in the experiment	
Reference		
1.	Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHI/School Bo	oks
2.	Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki PHI; 3 edition	2015
3.	Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals - PH	II; 2 edition (2011)
4.	Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Chetan 5 2013)	Singh Solanki PHI (1 January
5.	Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee, New Age Internatioanal Publish	er; First edition (2011)
6.	Science & Technology of Photovoltaics P Jayrama Reddy, BS Publications ,CRC Press 2010 11. Fro Practical Handbook on Solar Photovoltaic Applications, Suneel Deambi, The Energy and Resources Instit	m Sunlight to Electricity: A ute, TERI (30 January 2009)
VDTG202	Waste to Energy Conversion Systems	5(3+2)

VRTS302	Waste to Energy Conversion Systems	5(3+2)
Unit I:	<b>Introduction :</b> Introduction to waste and waste processing, Definitions, sources, types and composition of various Characterization of Municipal Solid Waste (MSW), Industrial waste and Biomedical Waste (BMW), Wast transportation; Waste processing-size reduction, Separation; Waste management hierarchy, Waste minimization MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), Recycling processes of solid waste.	s types of wastes e Collection and and recycling o

Waste Treatment and Disposal : Aerobic composting, Incineration, different type of incineration; medical and pharmaceutical waste Unit II: incinerations, Landfill classification, types, methods and sitting consideration, layout and preliminary design of landfills: composition, characteristics, generation, movement and control of landfill leachate and gases, environmental monitoring system for land fill gases, Rules related to the handling, treatment and disposal of MSW and BMW in India.

Unit III: Waste to Energy Conversion Technologies : Sources of energy generation, incineration, gasification of waste using gasifiers, briquetting, Utilization and advantages of briquetting. Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, land fill gas generation and utilization,

Unit IV: Environmental and Commercial Aspects of Waste to Energy Present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages, Environmental and health impacts of incineration and other waste to energy conversion systems, case studies of commercial waste to energy plants, Strategies for reducing environmental impacts.

#### Text Books:

- 1. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic,
- Technical, and Renewable Comparisons, ISBN:9780470539675, John Wiley and Sons. 1.
- Velma I. Grover and Vaneeta Grover, Recovering Energy from Waste Various Aspects, ISBN 978-1-57808-200-1. 2.

Shah, Kanti L., Basics of Solid and Hazardous Waste Management Technology, Prentice Hall. 3.

- 4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers.
- 5. Marc J. Rogoff, Waste-to-Energy, Elsiever.
- Parker, Colin and Roberts, Energy from Waste An Evaluation of Conversion Technologies, Elsevier Applied Science, London. 6.
- 7. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House.
- 8. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi.

#### VRTS303

Solar Thermal Energy Technology

- Unit-1: Solar Radiation and its Measurement : Solar radiation and its significance in energy use, Measurement of Solar Radiation-Pyranometer, Pyrheliometer, Sunshine Recorder; Radiation Characteristics of Opaque Materials, Radiation Transmission through covers and Absorption of Collectors, Devices for Thermal Collection and Storage, Thermal applications. Liquid Flat Plate Collector (FPC)- Definition, Characteristic Features of FPC, Performance Analysis, Transmissivity Absorptivity Product, Overall Loss Coefficient and Heat Transfer Correlations, Collector Efficiency Factor, Effects of Various Parameters on Performance, Advantages of Flat plate Collector, Alternatives to the Conventional Collector. Solar Air Heaters- Introduction, Performance Analysis of Solar Air Heater, Types of Air Heaters- Collector with Non-Porous Absorber, Collector with Porous Absorber, Testing Procedure of Solar Air Heater, Application of Solar Air Heater
- Unit-2: Solar Collectors (other than concentrators) : Fundamentals of solar collectors as devices to convert solar energy to heat, Non-concentrating low temperature flat-plate and evacuated tube collectors, Design and structures of collectors for heating liquids and air. Performances of Flat Plate Collectors- Optimal collector tilt and orientation, Collector performance, Useful energy gain, energy losses, efficiency, Use of selective coatings to enhance the collector efficiency, Concentrating collectors for middle and high temperature applications. Applications of Solar Collectors- Application of non-concentrating collectors in low temperature solar thermal plants for space heating and cooling, drying, seawater desalination, use of concentrating collectors for process heat production and power generation.
- Unit-3: Solar Concentrators : Solar Concentrating Collectors- Introduction, Performance of Solar Concentrators, Concentrating collector performance- concentration ratio, useful energy, gain, energy losses, efficiency, Solar collector design, testing, installation and operation. Plane receiver with plane collectors, compound parabolic with plane collectors, cylindrical parabolic collectors, Collector with fixed circular concentrator and a moving receiver, Fresnel lens collector, paraboloid dish collector, heliostat field with central receiver.
- Unit-4: Solar Water Heating and Cooling Systems : Flat plate collector: Liquid and air heating Thermosiphon & Forced; Evacuated tubular collectors Overall heat loss coefficient, heat capacity effect Thermal analysis, Design of solar water heating systems, with natural and pump circulation, energy efficient landscape design, solar greenhouses, solar furnace and applications. Solar Passive Heating and Cooling-Direct heat gain, indirect heat gain, isolated gain and sunspaces, Passive cooling concepts Evaporative cooling, absorption cooling system, Passive desiccant cooling, application of wind, water and earth for cooling, roof cooling, earth air-tunnel.
- Unit-5: Thermodynamic Cycles and Power Plants: The Carnot Cycle, The Rankine Cycle, The Stirling Cycle, The Brayton Cycle, Combined Cycle Power Plant, Solar Pomping System, Solar Air Heaters Solar Crop Drying, Solar Kilns, Integrated Solar Dryers, Distribution Solar Dryers. Solar Thermal Power Plants- Low temperature solar power plant, Medium temperature solar power plant, High temperature solar mover generator, Central receiver power plants, Solar thermal electric power plants based on parabolic trough, Concentrated solar power using Fresnel lenses, Fundamentals of design calculations and analysis of solar power plants.

#### **RECOMMENDED REFERENCES:**

- 1. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman, John Wiley & sons.
- 2. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals PHI; 2 edition (2011)
- 3. Solar Energy, Fundamentals, Design, Modelling & Applications, G.N.Tiwari, Narosa Publishing House.
- 4. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Chetan Singh Solanki, PHI (1 January 2013)
- 5. Fundamentals of Renewable Energy Systems Paperback D. Mukherjee, New Age International Publisher; First edition (2011)
- 6. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki PHI; 3 edition 2015.
- 7. From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications, Suneel Deambi, The Energy and Resources Institute, TERI (30 January 2009).

#### **TEXT BOOKS:**

- 1. Non-Conventional Energy Sources, G.D. Rai, Khanna Publishers.
- 2. Non-Conventional Energy Resources, B.H. Khan, The McGraw-Hill Publications.
- 3. S.P. Sukhatme and J.K. Nayak, Solar Energy Principles of thermal collection and storage; Tata McGraw-Hill, New Delhi
- 4. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill
- 5. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, London
- 6. M.S. Sodha, N.K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York
- 7. M.A.S. Malik, G.N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation Pergamon Press, New York
- 8. Gilbert M. Masters, Renewable and efficient electric power systems, Prentice-Hall
- 9. C.S. Solanki, Solar Photovoltaics: Fundamental, technologies and applications, Prentice Hall of India

VRTG306	ENVIRONMENT STUDIES AND DISASTER MANAGEMENT	3(2+1)

#### Unit - 1: Multi-disciplinary nature of environment

**Definition and Composition of Environment** – Lithosphere, Hydrosphere, Atmosphere, Biosphere, Hydrological Cycle; Historical Development, approaches, scope and importance of Environment Studies

Man and Nature- relation and interaction with respect to Food, Clothing, Shelter and Occupation Concept of Ecology and Ecosystem- Structure, types and function of different ecosystems- Forest, Grassland, Dessert, Aquatic ecosystems; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids Bio-diversity-definition, genetic, species and ecosystem diversity, Bio-geographical classification of India; Value of Bio-diversity:

consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, National and local levels, India as a mega-diversity Nation, Threats to Bio-diversity; Habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India; Conservation of Bio-diversity- In- situ and Ex- situ conservation of Bio-diversity

#### Unit -2: Resources, Wealth and Environmental Protection

Natural Resources- Meaning and Types of Resources- Forest resources, Mineral resources, Water resources, Food resources, Land resources, Energy resources; Use and over exploitation of resources- its effect, use of technology and its impact on natural environment

Wealth – meaning, Distinction between wealth and resources, Optimum Conversion of Resources into wealth; Measures for conservation of natural resources, Water conservation, rain water harvesting, watershed management, Wasteland reclamation, Use of Renewable Energy Sources, Consumerism and waste products

**Environmental and other affects** of (a) deforestation (b) mining (c) dams and reservoirs (d) Modern agriculture (e) industries (f) other developmental projects; Resettlement and rehabilitation of people; its problems and concerns: case studies

Environmental Ethics- Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust., Case studies; Conflict between development and environmental conservation, Equitable use of resources for

sustainable lifestyles, Need for public awareness, Role of an individual in conservation of natural resources, Role of and Measures to increase public awareness towards environmental issues- Role of family, schools, Government and NGO institutions, Role of Information Technology in environmental issues

#### Unit - 3: Environmental Pollution, Waste Management and Environmental Protection (8 lectures)

**Environmental Pollution** - Definition, Causes, effects and control measures of different types of environmental pollution- (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution, (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards; Role of individual in prevention of pollution, case studies

Waste Management- Domestic, Industrial; Solid waste Management- Causes, effects and control measures of urban and industrial wastes; Measures taken by Government and Non Government bodies; Laws governing industrial waste disposal; Recycling of waste; Case studies

**Environmental Protection and Assessment** – Actions for environmental Protection, National and international initiatives, emerging environment management strategies, Indian initiatives, Environmental Protection Movements and NGOs in India; Environmental Impact Assessment (EIA), Environmental Auditing, Environmental Legislation in India, Carbon Bank ;

Legislative measures: Issues involved in enforcement of environmental legislation Environment Protection Act, Air (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act

#### Unit – 4: Hazards and Disasters

**Definitions and Principles-** Emergency, Vulnerability, Population displacements, Complex emergencies, Classification of Disasters, Levels of Disaster, Effect of Disasters, Causal Factors of Disasters, Poverty, Population Growth, Rapid Urbanisation, Transition in Cultural Practices, Environmental Degradation, Climate Change, Typology of Disasters, Lack of Awareness and Information, War and Civil Strife, Phases of Disaster, Rapid Onset Disasters, Slow Onset Disasters

Natural Calamities- Calamities of Meteorological/ Climatic Origin, Calamities of Hydrological Origin, Calamities of Geological Origin, Calamities of Extra-Terrestrial Origin; Earthquakes, tsunamis,Tropical Cyclones, Floods, Droughts, Human Epidemics and Pandemics, Exotic Animal Diseases, Insect and Vermin Plagues

Man made disasters- Terrorism, Technological Hazards, Structure Collapse, Fire, Hazardous and Toxic Materials, Transportation, Space Disasters, Chemical and Industrial Accidents

**Human Body and effect of disaster on it-** Basics of Body Systems, Nervous Systems, Reproduction system, Immune system; Impact of disasters on Human Health ,Biological hazards, Chemical hazards, Physical hazards, Sociological hazards, Biological effects of massive chemical exposures, Feeding mega doses, Cancer and the environment, Infectious diseases, Anthrax, Food borne diseases, Dengue Fever, Flu (Influenza), Bird (Avian) Flu, Plague, Severe Acute Respiratory Syndrome (SARS), Tuberculosis (TB), Diseases caused by environmental pollution, water and air borne diseases, WHO's Goal

#### Unit - 5: DISASTER PREVENTION AND CONTROL

**Disaster Management in India**: National Policy, Historical Framework, Indian Agencies for Disaster Management, Indian Red Cross Society, National Institute of Disaster Management, Niti Ayog (erstwhile Planning Commission), National Civil Defence Organisation, The Bharat Scouts & Guides, National Crisis Management Committee (NCMC), Crisis Management Group, The Disaster Management Act, 2005, The National Disaster Management Authority (NDMA), State Disaster Management Authorities, District Disaster Management Authority, Role of District Magistrate, National Disaster Response Force (NDRF), Indian Paramilitary Forces, Role of Armed Forces in Disaster Relief

International Practices- The United Nations System, United Nations Disaster Relief Coordinator (UNDRO), UNDRO Mandate in Disaster Relief and Management, General Assembly, Guiding Principles, Prevention, Preparedness, Stand-By Capacity, Consolidated Appeals; Coordination, Cooperation And Leadership; Continuum From Relief To Rehabilitation And Development, International Decade For Natural Disaster Reduction, Yokohama Conference, Kobe Conference, Plan of Action

**Predictability and Preparedness** – Introduction of the Instruments used in Metreology, Climatalogy Hydrology and Seismology; Epidemics- Causal Phenomena, Typical Effects, General Characteristics, Possible Risk reduction measures, Predictability, Specific Preparedness Measures, Factors Contributing to Vulnerability, Typical Post-Disaster Needs, Case studies

Continuous Internal Assessment: Projects / Presentations / GD /Tests

#### Practical

6.

- 1. Visit to a local area to document environmental assets- river/ forest/ grassland/hill/ mountain.
- 2. Visit to a local polluted site- Urban/ Rural/ Industrial/ Agricultural.
- 3. Study of common plants, insects, birds.
- 4. Study of simple ecosystems- pond, river, hill slopes, etc.
- 5. Case studies related to
  - i. Deforestation
  - ii. Dams
  - iii. Mining
  - iv. Water logging and salinity
  - v. Land degradation
  - vi. Land slides
  - Specific Case Studies
  - Chernobyl Nuclear Accident: Disaster and Development
  - Drought in India and the Water Crisis: Disaster and Development
  - Mumbai Floods: Disaster and Development
  - Orissa Cyclone in 1999: Meteorological Disaster
  - Monsoon Floods in India: Hydrological Disaster
  - Train Accidents in India: Transportation Disaster
  - Pandemic Lessons: Avian Flu of 1918: Epidemic/Pandemic Disaster
- 7. Movies:
  - 1. An Inconvenient Truth, Al Gore
  - 2. The 11th Hour, Leonardo DiCaprio
  - 3. The Age of Stupid. Franny Armstrong.
  - 4. Baraka, Ron Fricke.
  - 5. Climate change: An Untold Story [Climate's First Orphans;
  - 6. The Weeping Apple Tree; A Degree of Concern; A Green Agony], Discovery Channel.
  - 7. Liquid city--Mathew Gandy.
  - 8. Story of Stuff -- Free Range Studios Tides Foundation.
  - 9. Story of bottled water---Free Range Studios Tides Foundation

#### **Recommended Books:**

. R. Rajagopalan, R. Environmental Studies – From Crisis to Cure, Delhi

- 2. Guha Ramachandra Environmentalism: A global history
- 3. Environmental Studies, Gupta A.K and Kaur G., 4th edition, Tara Publications, Yamuna Nagar, Haryana.
- 4. Environmental Chemistry, A.K. De, Wiley Eastern Ltd., New Delhi.
- 5. Environmental Biotechnology, Agarwal S.K., APH Publishing Corporation, New Delhi
- 6. Environmental Science and Technology, Stankey E.M., Lewis Publishers

VRTG305	Computer Programming and Web Designing (CPWD)	3(1+2)

- UNIT-1: Concepts of HTML: Basic principles involved in developing a web site, Planning process, Golden rules of web designing, Design Concept, Designing navigation bar, Page design, Home Page Layout, Introduction to elements of HTML, HTML and its version, HTML Documents, Basic structure of an HTML document, Creating an HTML document, Colors and its values, Mark up Tags, Heading-Paragraphs, Line Breaks, HTML Tags, Working with Text, Working with Lists, Tables and Frames, Hyperlinks, Images and Multimedia, Forms and controls, Multimedia applications
- UNIT-2: Concepts of CSS: Introduction of CSS, Creating Style Sheet, CSS Properties, CSS Styling (Background, Text Format, Controlling Fonts), Working with block elements and objects, Working with Lists and Tables, CSS Id and Class, Box Model (Introduction, Border properties, Padding Properties, Margin properties), CSS Advanced (Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector), CSS Color, Creating page Layout and Site Designs.
- UNIT-3: JAVA Script & Web Hosting: Introduction to JavaScript, Basic Syntax, Control Structures, Writing Functions, Working with Arrays, The Document Object Model, Events Handling, Browser Objects, Object Oriented concept of JavaScript, Understanding FTP, Setting up FTP Server (Live), Uploading and downloading FTP contents, Deploying application on Web Server, Preparing HTML from Design, Hosting on Live Server
- **UNIT-4:** Concept of DBMS: Database System, Purpose of database system, view of data, relational databases, database architecture, The importance of data models, Basic building blocks, Business rules, The evolution of data models, Degrees of data abstraction. Database design and ER-Model, Constraints, weak entity sets, Codd's rules, Relational Schemas, keys, integrity rules, Relational algebra, Operators, grouping and ungrouping, Tuple's relational calculus, Domain relational Calculus, computational capabilities etc
- UNIT-5: Working With MySQL/SQL: Client/Server Concepts, Database and Database Objects, Data Definition using SQL : Databases, Data Types, Tables, Constraints and Indexes, Views, Recurring SQL Constructs, Adding data, Modifying data, Removing data, Searching data, Expressions, Grouping and Aggregate Functions, Joining Tables, Transaction Concepts, SQL for working with Transaction, Tools for Import/Export, SQL for Import/Export

#### **PRACTICALS:**

The entire practical will be as per the theory. Contents of the theory have to be practiced in practical classes and records have to be prepared.

#### List of Books for B.Voc.

- 1. R. Rajagopalan, R. Environmental Studies From Crisis to Cure
- 2. Guha Ramachandra, Environmentalism: A global history
- 3. Environmental Studies, Gupta A.K and Kaur G., Tara Publications, Yamuna Nagar, Haryana.
- 4. Environmental Chemistry, A.K. De, Wiley Eastern Ltd., New Delhi.
- 5. Environmental Biotechnology, Agarwal S.K., APH Publishing Corporation, New Delhi
- 6. Environmental Science and Technology, Stankey E.M., Lewis Publishers
- 7. Non-Conventional Energy Sources, G.D. Rai, Khanna Publishers.
- 8. Non-Conventional Energy Resources, B.H. Khan, The McGraw-Hill Publications.
- 9. S.P. Sukhatme and J.K. Nayak, Solar Energy Priniciples of thermal collection and storage; Tata McGraw-Hill, New Delhi
- 10. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill
- 11. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, London
- 12. M.S. Sodha, N.K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York
- 13. M.A.S. Malik, G.N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation Pergamon Press, New York
- 14. Gilbert M. Masters, Renewable and efficient electric power systems, Prentice-Hall
- 15. C.S. Solanki, Solar Photovoltaics: Fundamental, technologies and applications, Prentice Hall of India
- 16. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman, John Wiley & sons.
- 17. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C, New Arrivals PHI; 2 edition
- 18. Solar Energy, Fundamentals, Design, Modelling & Applications, G.N.Tiwari, Narosa Publishing House.
- 19. Fundamentals of Renewable Energy Systems Paperback D. Mukherjee, New Age International Publisher;
- 20. From Sunlight to Electricity: A Practical Handbook on Solar Photovoltaic Applications, Suneel Deambi, The Energy and Resources Institute, TERI
- 21. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic,
- 22. Technical, and Renewable Comparisons, ISBN:9780470539675, John Wiley and Sons.
- 23. Velma I. Grover and Vaneeta Grover, Recovering Energy from Waste Various Aspects, ISBN 978-1-57808-200-1.
- 24. Shah, Kanti L., Basics of Solid and Hazardous Waste Management Technology, Prentice Hall.
- 25. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers.
- 26. Marc J. Rogoff, Waste-to-Energy, Elsiever.
- 27. Parker, Colin and Roberts, Energy from Waste An Evaluation of Conversion Technologies, Elsevier Applied Science, London.
- 28. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House.
- 29. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi.
- 30. Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHIISchool Books
- 31. Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki PHI;
- 32. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Singal K. C
- 33. Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, Chetan Singh Solanki PHI
- 34. Fundamentals of Renewable Energy Systems Paperback D. Mukherjee, New Age Internatioanal Publisher
- 35. Fluency in English Part II, Oxford University Press
- 36. Business English, Pearson
- 37. Language, Literature and Creativity, Orient Blackswan,
- 38. LALA, PUSHP and Sanjay Kumar. 'Communicate or collapse: a handbook of effective public speaking, group discussions and interviews'. PHI Learning Pvt. Ltd.
- 39. H.M.Prasad, 'How to prepare for Group Discussion and Interview'. Tata McGrawHill,
- 40. R.S. Aggarwal, 'A Modern Approach to Verbal & Non-Verbal Reasoning', S. Chand & Co,
- 41. Aysha Viswamohan, "English for Technical Communication", Tata Mc-Graw Hill Publishing Company Ltd., New Delhi
- 42. E.Suresh Kumar and P. Sreehari, "A Handbook for English Language Laboratories", Osmania University, Hyderabad
- 43. Electrical Technology, Naidu-Kamakshaiah, Tata McGraw-Hill Education

- 44. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI Learning Pvt. Ltd.
- 45. A Text Book of Electrical Technology, B.L. Theraja, S. Chand Limited
- 46. Photovoltaics: Design and Installation Manual, Solar Energy International
- 47. Renewable Energy Technologies: A Practical Guide for Beginners, Chetan Singh Solanki, PHI School Books
- 48. Fundamentals of Renewable Energy Systems Paperback D. Mukherjee, New Age International Publisher;
- 49. G. D. Rai, Non- conventional Sources of Energy, Khanna Publishers, Delhi.
- 50. A Course in Electrical and Electronic Measurements and Instrumentation, A. K Sawhney, Dhanpat Rai & Co.
- 51. Electronic Instrumentation & Measurement by WilliamD Cooper & Albert C.Helfric, PHI Pub.
- 52. Instrumentation, Measurement & Analysis by K.K. Chaudhury & R.C.Nakra, TMH.
- 53. OP-AMP and linear integrated circuits 2nd edition, PLHI by Ramakant A. Gayakwad.
- 54. Integrated Electronics by Millman & Halkias, TMH Publishing Co.
- 55. Electronic Instrumentation, H S Kalsi, Tata McGraw-Hill Education.
- 56. Instrumentation Devices and Systems, C.S. Rangan, Tata McGraw-Hill Education.
- 57. Basic Electronics and Linear Circuits, Bhargava, Kurukshetra & Gupta Tata McGraw-Hill Publishing Ltd.
- 58. Applied Electronics, R S Sedha, S. Chand and Company Ltd.
- 59. Principles of Electronics, V.K. Mehta, S.Chand and Company Ltd.
- 60. Electronics Service Technology Vol-1. Saji A.G, Shyam Mohan , Ayodhya publications
- 61. Integrated Electronics, Jacob Millman and C. Halkias Mill, Tata McGraw-Hill Publishing Ltd
- 62. Science & Technology of Photovoltaics P Jayrama Reddy, BS Publications , CRC Press
- 63. Solar Electricity Handbook A Simple Practical Guide to Solar Energy- Designing and Installing Photovoltaic Solar Electric Systems, Michael Boxwell, Greenstream Publishers
- 64. Photovoltaics: Design and Installation Manual, Solar Energy International
- 65. Solar Electric Handbook: Photovoltaic Fundamentals and Applications, Solar Energy International