PONDICHERRY UNIVERSITY
PUDUCHERRY

ACADEMIC CURRICULUM

(SYLLABUS AND REGULATIONS)

FOR

B.Voc – GREEN ENERGY AND ELECTRICAL SYSTEMS

BACHELOR OF VOCATIONAL DEGREE

CHOICE BASED CREDIT SYSTEM

(from the Academic Year 2022-23 onwards)

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1. Introduction

About B.Voc

Realizing the importance and the necessity of developing skills among students, and creating work-ready manpower on large scale especially to meet the demand-supply mismatch in the Indian Economy, the University Grants Commission (UGC), Ministry of HRD, Government of India had launched a scheme on 27 February 2014 for skills development based higher education as part of college/university education, leading to Bachelor of Vocation (B.Voc.). In these courses, the institute will conduct general education content and sector-specific skills will be imparted by Skill Knowledge Providers/ Training Providers/ Industries.

2. ELIGIBILITY FOR ADMISSION:

Candidates for admission to B.Voc (Production Technology) shall be required to have passed 10+2 or 10+ITI (2 years) or its equivalent from a recognized board of examination.

3. Key Features:

Objectives

- To provide a judicious mix of skills relating to a profession and appropriate content of General Education.
- To ensure that the students have adequate knowledge and skills so that they are work-ready at each exit point of the programme.
- To provide flexibility to the students through pre-defined entry and multiple exit points.
- To integrate National Skills Qualifications Framework (NSQF) within the undergraduate level of higher education to enhance the employability of the students and meet industry requirements. Such student apart from meeting the needs of local and national industries are also expected to be equipped to become part of the global workforce.
- To provide vertical mobility to students admitted in such vocational courses.
- The certification levels will lead to Diploma/Advanced Diploma/B. Voc. Degree in Green Energy and electric systems and will be offered by Pondicherry University.
- Students may be awarded Level Certificate/Diploma/Advance Diploma /Degree as outlined in the Table:

Award	Course	Duration after class XII	Corresponding NSQF level
Level 4 Certificate	Certificate	06 Months (30 Credits)	**4**
Level 5 Certificate	Diploma	1 Year (60 Credits)	**5**
Level 6 Certificate	Advance Diploma	2 Year (120 Credits)	**6**
Level 7 Certificate	**B.Voc. Degree**	**3 Year (180 Credits)**	**7**

4. Course Objectives

After successfully completing the vocational course, the student would have acquired relevant appropriate and adequate technical knowledge together with the professional skills and competencies in the field of Green Energy so that he/she is properly equipped to take up gainful employment in this Vocation. Thus he/she should have acquired:

A. Understanding of

(a) The relevant basic concepts and principles in basic science subjects (Physics and Mathematics) so that he/she is able to understand the different vocational subjects.

(b) The basic concepts in engineering drawing using AUTOCAD.

(c) Understanding various rules and regulations in electrical and green energy.

(d) The concepts, and principles of working with different electrical & energy measuring tools.

(e) Importance of Renewable energy systems.

(f) The knowledge of Green Energy & Electrical systems.

(g) Understating of energhttps://youtu.be/MBmr1j2hy6Uy utilization.

(h) The concepts and principles used in Renewable energy systems.

B. Adequate Professional Skills and Competencies in

1. Have adequate knowledge and skills to prep them ready for the job in this field.
2. Be capable to understand the positive aspects of Renewable Energy Technology concerning the environment.
3. Handle the installation and commissioning of solar projects in rural and urban areas.
4. Be capable to create direct and indirect employment opportunities in rural and backward areas.

C. A Healthy and Professional Attitude so that He/ She has

(a) An analytical approach while working on a job.

(b) An open mind while locating/rectifying faults.

(c) Respect for working with his/her own hands.

(d) Respect for honesty, punctuality, and truthfulness

D. NSQF compliant skills in Qualification developed by sector skill council in Capital Goods Sector.

5. Course Structure

The course will consist of a combination of practice, theory and hands-on skills in the Power Generation Sector. The curriculum in each of the years of the programme would be a suitable mix of general education and skill development components.

Skill Development Components:

- The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work ready. The skill development components will be relevant to the industry as per its requirements.
- The curriculum will necessarily embed within itself, National Occupational Standards (NOSs) of specific job roles within the industry. This would enable the students to meet the learning outcomes specified in the NOSs.
- The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in a few domains.
- The curriculum will focus on work-readiness skills in each of the years of training.
- Adequate attention will be given in curriculum design to practical work, on-the-job training, development of student portfolios and project work.

General Education Component:

- The general education component adheres to the normal senior secondary and university standards. It will emphasize and offer courses which provide holistic development. However, it will not exceed 40% of the total curriculum.
- Adequate emphasis is given to language and communication skills.

The curriculum should be designed in a manner that at the end of year-1, year 2 and year-3, students can meet below mentioned level descriptors for levels 5, 6 and 7 of NSQF, respectively which are as given below:

Level	Process required	Professional Knowledge	Professional skill	Core skill	Responsibility
Level 5	Job that requires well developed skill, with clear choice of procedures in familiar context	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools materials and information	Desired mathematical skill, understanding of social, political and some skill of collecting and organizing information, communication.	Responsibility for own work and learning and some responsibility for other's works and learning
Level 6	Demands wide range of specialized technical skill, clarity of knowledge and practice in broad range of activity involving standard/ non-standard practices	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Reasonably good in mathematical calculation, understanding of social, political and reasonably good in data collecting organizing information, and logical communication	Responsibility for own work and learning and full responsibility for other's works and learning
Level 7	Requires a command of wide ranging specialized theoretical and practical skill, involving variable routine and non-routine context	Wide ranging, factual and theoretical knowledge in broad contexts within a field of work or study	Wide range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Good logical and mathematical skill understanding of social political and natural environment good in collecting and organizing information, communication and presentation skill	Full responsibility for output of group and development

ASSESSMENT

THEORY COURSES

All theory courses shall be assessed as follows:

Assessment Method	Marks
Continuous Assessment (Internal)	40
Semester Examination (External)	60
Total	100

Continuous Assessment (Internal)

Continuous Assessment (Internal)	Marks
Attendance	05
Internal Assessment Test	25
Assignments	10
Total	40

Attendance carries 5 marks (5 marks for 100% to 95% attendance, 4 marks for 94% to 90% attendance, 3marks for 89% to 85% attendance, 2 marks for 84% to 80% attendance and 1 mark for 79% to 75% attendance), cycle test carries 25 marks. Performance in the best two of the three tests will be taken for assessment. Assignments carrying 10 marks, shall be in the form of problems, small projects, quizzes, design problems, etc., depending upon the subject content.

Semester Examination

The pattern of Semester Examination question papers for theory courses is as follows:

a) The duration of the examination shall be 3 hours with a maximum of 60 marks.

b) Section A contains 5 compulsory questions each carrying 2 marks. Only one question shall be selected from each unit. This section carries 10 marks in total.

c) Section B contains five questions, one question from each unit with *'either' 'or' choice*. Each question carries ten marks. Based on necessity, each question may contain sub-divisions. This section carries 50 marks in total.

PRACTICAL COURSES:

All practical courses shall be assessed as follows:

Assessment Method	Marks
Continuous Assessment	40
Semester Examination	60
Total	100

Continuous Assessment (Internal)

Continuous Assessment (Internal)	Marks
Attendance	05
Model examination	15
Regular Laboratory Work	20
Total	40

Attendance carries 5 marks (5 marks for 100% to 95% attendance, 4 marks for 94% to 90% attendance, 3 marks 89% to 85% attendance, 2 marks for 84% to 80% attendance and 1 mark for 79% to 75% attendance). The regular performance in the practical class (Observation and Record) will be evaluated for 20 marks. Performance in the Model examination conducted at the end of the semester will be evaluated for 15 marks. The pattern of the Model Examination will be similar to the Semester Examination.

Semester Examination

The Semester Examination of the practical courses will be evaluated for 60 marks by a panel of examiners comprising an internal examiner and an external examiner. The Break-up of marks is as follows:

Procedure : 10 marks
Practical work and calculations : 40 marks
Viva-Voce : 10 marks

PROJECT WORK

The Project work carried out in the seventh and eighth semesters- shall be assessed as follows:

Assessment Method	Marks
Continuous Assessment (Internal Evaluation)	60
Semester Examination (External Evaluation)	40
Total	100

ii) Marks allocated for *Continuous Assessment* are distributed as given in the following table.

Assessment Method	Marks
Guide	25
Project Evaluation Committee	35
Total	60

a) The guide shall evaluate the student for 25 marks based on the work carried out.

b) The Project Evaluation Committee comprising the Head of the Department and two other faculty members shall evaluate the project for 35 marks. The evaluation will be carried out through three reviews. The Project Evaluation Committee is constituted by the Head of the Department.

iii) The final *Semester Examination* of the Project Work will be conducted by a panel of examiners comprising an internal examiner and an external examiner. The Break-up of marks is as follows:

Project report : 15 marks
Presentation : 15 marks
Viva-Voce : 10 marks

THEORY cum PRACTICE COURSES

All theory cum practice courses shall be assessed as follows:

Assessment Method	Marks
Continuous Assessment (Internal)	40
Semester Examination (External)	60
Total	100

Continuous Assessment (Internal)

Continuous Assessment (Internal)	Marks
Attendance	05
Internal Assessment Test	15
Regular Laboratory work	15
Total	40

Attendance carries 5 marks (5 marks for 100% to 95% attendance, 4 marks for 94% to 90% attendance, 3marks for 89% to 85% attendance, 2 marks for 84% to 80% attendance, and 1 mark for 79% to 75% attendance), Internal Assessment test comprises of cycle test carries 15 marks (Performance in the best two of the three tests will be taken for assessment) and the model examination conducted at the end of the semester and regular performance in the practical class (Observation and Record) will be evaluated 15 marks.

Semester Examination

The *Semester Examination* will be conducted as Semester Examination theory and semester Examination Practical each carries 30 Marks.

The pattern of Semester Examination question papers for theory courses is as follows:

a) The duration of the examination shall be 2 hours with a maximum of 30 marks.
b) Section A contains five questions, one question from each unit with *'either' 'or' choice*. Each question carries six marks. Based on necessity, each question may contain sub-divisions.

The Semester Examination of the practical courses will be evaluated for 30 marks by a panel of examiners comprising an internal examiner and an external examiner. The Break-up of marks is as follows:

Procedure	: 10 marks
Practical work and calculations	: 15 marks
Viva-Voce	:05 marks

ON JOB TRAINING

Depending on the job role (Qualification Packs) that the students have chosen in the industries, the assessment for on-the-job training will be carried out in accordance with the relevant Skill Sector Council.

DECLARATION OF RESULTS

Examination Passing Criteria:

i) A student is declared to have ***passed*** a course if he gets 40% marks and above in the Semester Examination and 50% marks and above overall (Semester Exam marks and Continuous Assessment marks put together).

ii) If a student fails to clear the semester examination of a theory course after three consecutive attempts, the passing criteria from the fourth attempt onwards will be based on the marks earned by the student in the end-semester examination only. The student is deemed to have passed the course if the mark scored in the end semester examination is 50% and above and he will be awarded only an **C grade** irrespective of the mark scored.

AWARD OF GRADES

The performance of students in a course is expressed in terms of Letter Grades, each carrying certain Grade Points. A total of Six Passing Grades namely O, A+, A, B+, B, and C is awarded. Total marks (s*um of Continuous Assessment and Semester Examination marks*) secured by a student in a course are used for computing his Grade by fitting the mark into the Range of Marks assigned for each Grade shown in the table below.

Range of Marks	**Letter Grade**	**Grade Points**
91 to 100	O	10
81 to 90	A+	9
71 to 80	A	8
61 to 70	B+	7
56 to 60	B	6
50 to 55	C	5
0 to 49	F	0
Absent	FA	0

8.2 A student who has secured an 'F' and 'FA' grade shall reappear for the examination in the following semesters. A student who has scored a passing grade other than an "F" and "FA" cannot reappear for the examination.

8.3 A student securing 'F' grade in an elective course may reappear for the examination in the following semester or drop the elective course and subsequently register for another elective course in the following semester in place of the dropped elective course.

8.4 *Grade Point Average* (GPA) indicates the performance of a student in all the examinations appeared by him in a particular semester. GPA score will appear in all the Semester Examination Grade Cards. The *Grade Point Average* (GPA) for a particular semester is calculated as the ratio of the sum of the products of the number of Credits of a course *(C_i)* and the Grade Points scored in that course *(GP_i)*, taken for all the courses, to the sum of the number of credits of all the courses (*n*) registered in that semester.

$$GPA = \frac{\sum_1^n C_i GP_i}{\sum_1^n C_i}$$

where, *n* is the number of courses registered in that semester. For a student who has partially withdrawn from writing examinations of courses in a semester, *n* is counted as the total number of courses that appeared in that semester minus the number of courses partially withdrawn.

8.5 *Cumulative Grade Point Average* (CGPA) indicates the performance of a student in all the examinations appeared by him up to a particular semester. CGPA score will appear in all the Semester Examination Grade Cards starting from the first semester. The *Cumulative Grade Point Average* (CGPA) up to a particular semester is calculated as follows:

$$CGPA = \frac{\sum_1^n C_i GP_i}{\sum_1^n C_i}$$

where, C_i is the Credit of a course, GP_i is the Grade Point obtained by the student in that course and *N* is the total number of courses registered up to that semester starting from the first semester

Declaration of Class:

The class shall be awarded on the basis of CGPA as follows:

CGPA	CLASS
9.00 and above	**First Class with Distinction (In First Attempt)**
6.00 to 8.99	**First class**
5.00 to 5.99	**Second**

Conversion of CGPA into Percentage

The conversion of CGPA into percentage marks is as given below

Percentage (%) Mark = CGPA x 10

For Ex: If CGPA is 6.73, Percentage of Marks = 67.3%

CURRICULUM

Below Table shows for cumulative credits awarded to the learners in skill based vocational courses.

NSQF Level	Skill Component Credits	General Education Credits	Total Credits for Award	Normal Duration	Exit Points/ Awards
4	18	12	30	One Semester	Certificate
5	36	24	60	Two Semesters	Diploma
6	72	48	120	Four Semesters	Advanced Diploma
7	108	72	180	Six Semesters	B.Voc Degree

NSQF Level 4 SEMESTER - I							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
1	BVGEVC01	Basic Electrical & electronics	VC	4	0	0	4
2	BVGEVG01	Basic Programming	VG	3	0	0	3
3	BVGPGSH01	English - I	GSH	2	1	0	3
4	BVGPGSH02	Applied Mathematics - I	GSH	3	0	0	3
LABORATORY							
5	BVGEVC02	Engineering Drawing using AUTOCAD / FUSION(Theory cum Practice)	VC	2	0	4	4
6	BVGEVC03	Basic Electrical & electronics Lab	VC	0	0	8	4
7	BVGEVG02	Programming Lab	VG	0	0	6	3
8	BVGPGSH03	Applied Physics - I (Theory cum Practice)	GSH	2	0	2	3
9	BVGPGSH04	Integral Yoga & Values-based Life and Leadership for Human Unity- I (Theory cum Practice)	GSH	1	0	4	3
TOTAL CREDITS							**30**

NSQF Level 5 SEMESTER - II							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1	BVGEVC04	Introduction to Renewable Energy Sources	VC	4	0	0	4
2	BVGPGSH05	English - II	GSH	2	1	0	3
3	BVGPGSH06	Applied Mathematics - II	GSH	3	0	0	3
4	BVGPGSH07	Applied Physics - II	GSH	3	0	0	3
LABORATORY							
5	BVGEVC05	Basic Renewable Energy Lab	VC	0	0	8	4
6	BVGPGSH08	Integral Yoga & Values-based Life and Leadership for Human Unity- I Refresher and Application (Theory cum Practice)	GSH	1	0	4	3
ON-JOB-TRAINING (OJT)							
7	BVGEOJT01		OJT	8 weeks of Training			10
						TOTAL CREDITS	**30**

NSQF Level 6 SEMESTER - III							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1	BVGEVC06	Batteries Technology	VC	4	0	0	4
2	BVGEVC07	Solar Photovoltaic Technology	VC	4	0	0	4
3	BVGEVG03	Electrical Machines	VG	3	0	0	3
4	BVGPGSH09	Basic 3rd language (Hindi/German)	GSH	3	0	0	3
LABORATORY							
5	BVGEVC08	Battery and Photovoltaic Lab	VC	0	0	8	4
6	BVGEVG04	Electrical Machine Lab	VG	0	0	6	3
7	BVGPGSH10	Applied Chemistry (Theory cum Practice)	GSH	2	0	2	3
8	BVGPGSH11	Applied Physics II Practical	GSH	1	0	4	3
9	BVGPGSH12	Integral Yoga & Values-based Life and Leadership for Human Unity- II (Theory cum Practice)	GSH	1	0	4	3
			TOTAL CREDITS				**30**

NSQF Level 6 SEMESTER - IV							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1	BVGEVC09	Energy audit and management	VC	4	0	0	4
2	BVGPGSH13	Industrial management & Professional ethics	GSH	3	0	0	3
3	BVGPGSH14	Advanced 3rd language (Hindi/German)	GSH	3	0	0	3
4	BVGPGSH15	Online course*	GSH	3	0	0	3
LABORATORY							
5	BVGEVC10	Energy Audit Lab	VC	0	0	8	4
6	BVGPGSH16	Integral Yoga & Values-based Life and Leadership for Human Unity- II Refresher and Application (Theory cum Practice)	GSH	1	0	4	3
ON-JOB-TRAINING							
7	BVGEOJT02		OJT	8 weeks of training			10
						TOTAL CREDITS	**30**

*List of the courses and offering organization will be provided by the department.

NSQF Level 7 SEMESTER - V							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1	BVGEVC11	Solar Thermal Technology	VC	4	0	0	4
2	BVGEVC12	Bio energy Technology	VC	4	0	0	4
3	BVGEVEXX	Vocational Elective-I	VE	3	0	0	3
4	BVGEVG05	Material science and materials	VG	3	0	0	3
5	BVGPGSH17	Placement Training & Skill DevelopmentProgram - I	GSH	1	2	0	3
LABORATORY							
6	BVGEVC13	Bio energy and Solar Thermal Laboratory	VC	0	0	8	4
7	BVGPGSH18	Innovative and Design Thinking (Theory cum Practice)	GSH	1	0	4	3
EMPLOYABILITY/ENTREPRENEURSHIP ENHANCEMENT COURSE							
8	BVGEEEC01	Project Phase - I	EEC	0	0	12	6
			TOTAL CREDITS				**30**

NSQF Level 7 SEMESTER - VI							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1	BVGEVC14	Electric Vehicles	VC	4	0	0	4
2	BVGEVC15	Power Transmission and Distribution	VC	4	0	0	4
3	BVGEVEXX	Vocational Elective-II	VE	3	0	0	3
4	BVGPVG06	Maintenance and Safety in industry	VG	3	0	0	3
5	BVGPGSH19	Placement Training & Skill Development Program -II	GSH	1	2	0	3
LABORATORY							
6	BVGEVC16	Electric drives & Controller for e – vehicle lab	VC	0	0	8	4
7	BVGPGSH20	Integral Yoga & Values-based Life and Leadership for Human Unity- III (Theory cum Practice)	GSH	1	0	4	3
EMPLOYABILITY/ENTREPRENEURSHIP ENHANCEMENT COURSE							
8	BVGEEEC02	Project Phase - II	EEC	0	0	12	6
						TOTAL CREDITS	**30**

PROGRAMME TOTAL CREDITS=180

.

GENERAL SCIENCE AND HUMANITIES (GSH)

Sl. No	Course Code	Subject	Semester	Credits
1	BVGPGSH01	English - I	I	3
2	BVGPGSH02	Applied Mathematics - I	I	3
3	BVGPGSH03	Applied Physics - I (Theory cum Practice)	I	3
4	BVGPGSH04	Integral Yoga & Values-based Life and Leadership for Human Unity- I (Theory cum Practice)	I	3
5	BVGPGSH05	English - II	II	3
6	BVGPGSH06	Applied Mathematics - II	II	3
7	BVGPGSH07	Applied Physics - II	II	3
8	BVGPGSH08	Integral Yoga & Values-based Life and Leadership for Human Unity- I Refresher and Application (Theory cum Practice)	II	3
9	BVGPGSH09	Basic 3rd Language (Hindi/German)	III	3
10	BVGPGSH10	Applied Chemistry (Theory cum Practice)	III	3
11	BVGPGSH11	Indian culture and universal values	III	3
12	BVGPGSH12	Integral Yoga & Values-based Life and Leadership for Human Unity- II (Theory cum Practice)	III	3
13	BVGPGSH13	Industrial Management and Professional Ethics	IV	3
14	BVGPGSH14	Advanced 3rd Language (Hindi/German)	IV	3
15	BVGPGSH15	Online course	IV	3
16	BVGPGSH16	Integral Yoga & Values-based Life and Leadership for Human Unity- II Refresher and Application (Theory cum Practice)	IV	3
17	BVGPGSH17	Placement Training & Skill Development Program - I	V	3
18	BVGPGSH18	Innovative and Design Thinking (Theory cum Practice)	V	3
19	BVGPGSH19	Placement Training & Skill Development Program -II	VI	3
20	BVGPGSH20	Integral Yoga & Values-based Life and Leadership for Human Unity- III (Theory cum Practice)	VI	3
		TOTAL CREDITS		**60**

VOCATIONAL CORE COURSES (VC)

Sl. No	Course Code	Subject	Semester	Credits
1	BVGEVC01	Basic Electrical & electronics	I	4
2	BVGPVC02	Engineering Drawing using AUTOCAD (Theory cum Practice)	I	4
3	BVGEVC03	Basic Electrical & electronics Lab	I	4
4	BVGEVC04	Introduction to Renewable Energy Sources	II	4
5	BVGEVC05	Basic Renewable Energy Lab	II	4
6	BVGEVC06	Batteries Technology	III	4
7	BVGEVC07	Solar Photovoltaic Technology	III	4
8	BVGEVC08	Battery and Photovoltaic Lab	III	4
9	BVGEVC09	Energy audit and management	IV	4
10	BVGEVC10	Energy Audit Lab	IV	4
11	BVGEVC11	Solar Thermal Technology	V	4
12	BVGEVC12	Bio energy Technology	V	4
13	BVGEVC13	Bio energy and Solar Thermal Laboratory	V	4
14	BVGEVC14	Electric Vehicles	VI	4
15	BVGEVC15	Power Transmission and Distribution	VI	4
16	BVGEVC16	Electric drives & Controller for e – vehicle lab	VI	4
		TOTAL CREDITS		**64**

VOCATIONAL GENERAL (VG)

Sl. No	Course Code	Subject	Semester	Credits
1	BVGEVG01	Basic Programming	I	3
2	BVGEVG02	Programming Lab	I	3
3	BVGEVG03	Electrical machines	III	3
4	BVGEVG04	Electrical machines Laboratory	III	3
5	BVGEVG05	Material science and material	V	3
6	BVGPVG06	Maintenance and safety in industry	VI	3
		TOTAL CREDITS		**18**

VOCATIONAL ELECTIVE COURSES (VE)

Sl. No	Course Code	Subject	Semester	Credits
1	BVGEVE*	Vocational Elective-I	V	3
2	BVGEVE**	Vocational Elective-II	VI	3
		TOTAL CREDITS		**6**

Sl. No	Code No	Subject
1.	BVGEVE01	Energy, Environment and Renewable Energy Technologies
2.	BVGEVE02	Biomass Feedstock and Solid Biofuel Production
3.	BVGEVE03	Wind Energy & Small Hydropower Systems
4.	BVGEVE04	Waste to Energy Conversion
5.	BVGEVE05	Nanotechnology for Energy Systems

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	Course Code	Subject	Semester	Credits
1	BVGEEEC01	Project Phase - I	V	6
2	BVGEEEC02	Project Phase - II	VI	6
		TOTAL CREDITS		**12**

ON JOB TRAINING COURSE (OJT)

Sl. No	Course Code	Subject	Semester	Credits
1	BVGEOJT01	OJT – Solar / Wind /Biogas / E- Vehicle	II	10
2	BVGEOJT02	OJT – Solar / Wind /Biogas / E- Vehicle	IV	10
		TOTAL CREDITS		**20**

CREDIT DISTRIBUTION

SEMESTER	I	II	III	IV	V	VI	CREDIT
General Science and Humanities (GHS)	12	12	12	12	6	6	60
Vocational General (VG)	6		6		3	3	18
Vocational Core (VC)	12	8	12	8	12	12	64
Vocational Elective (VE)					3	3	6
Employability Enhancement Courses (EEC)					6	6	12
On Job Training Course (OJT)		10		10			20
TOTAL CREDITS	**30**	**30**	**30**	**30**	**30**	**30**	180

NON CGPA COURSES DETAILS

	I	II	III	IV	V	VI	VII
Sports			√	√	√	√	√
Library	√	√	√	√	√	√	√
Counseling	√	√	√	√	√	√	√

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC01	**BASIC ELECTRICAL & ELECTRONICS**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	To understand General knowledge about A.C & D.C systems
2	To explore electrical components & devices
3	To learn D C circuits
4	To learn electronics components and circuit, semiconductor devices
5	To know the working principles of AC and DC circuits

THEORY

UNIT	TITLE	PERIODS
1	**INTRODUCTION**	**14**

(i)General knowledge about A.C & D.C systems (Generation, Transmission & Distribution, both single phase & three phase in case of A.C system) (ii) General knowledge about conductors, insulators, semiconductors, resistors, fuse wires, electrical voltage, current, power & energy both in AC & DC systems. (iii) Selection and use of proper sizes, grades of solid & stranded conductors, use of wire gauge etc.

UNIT	TITLE	PERIODS
2	**ELECTICAL COMPONENTS & DEVICES**	**15**

Installation work of the classes and with the kinds of cables & wires for building wirings (for fans, lights, small motors and other appliances for domestic use) -Use of test lamps, bells, buzzer, continuity tester & battery in the testing requirements of circuits-Methods of testing out of polarity, phasing out of circuits- Connections and diagrams for main switches, distribution boards ceiling roses, plugs, sockets, switches (including 2 way), lamp holders, fans with regulators, MCCB, MCB, RLCB, ELCB, rotary switches and changeover switches etc.

UNIT	TITLE	PERIODS
3	**D C CIRCUITS**	**14**

Basic concepts of current, EMF, potential difference, resistivity, temperature coefficient of resistance – Ohm's Law – application of Ohm's law– resistance – series circuits – parallel and Series parallel circuits – Kirchhoff's laws –Problems in the above topics.

UNIT	TITLE	PERIODS
4	**ELECTRONICS COMPONENTS AND CIRCUIT**	**15**

IVPN junction diode – operation, forward, reverse bias characteristics- Half-wave rectifier and Full-wave rectifier- filters- PNP and NPN transistors – transistor current components – characteristics of transistor in CB, CE, CC configurations- JFET – construction – operation - drain and transfer characteristics- MOSFET – construction, operation and characteristics of EMOSFET, DMOSFET and VMOSFET

UNIT	TITLE	PERIODS
5	**SEMICONDUCTOR DEVICES**	14
Special Semiconductor Devices - Construction, principle of operation and characteristics of Schottky barrier diode, Varactor diode, Tunnel diode, PIN diode, LED, LCD, UJT, SCR, DIAC and TRIAC. Photoconductivity – photodiode, APD, phototransistor, LDR, optocoupler, solar cell, LASER diode and MOSFET.		
	TOTAL PERIODS:	72
COURSE OUTCOMES:		
Upon completion of this course, students will be able to:		
CO1:	Understand the basic terminology/definitions of electrical and electronics engineering	
CO2:	Apply the knowledge of theorems/laws to analyze the simple circuits	
CO3:	Use the principles of electromagnetic induction in electrical applications.	
CO4:	Construct and analyze simple AC circuits.	
CO5:	Select the electrical machines for different applications	
TEXT BOOKS:		
1	Hughes revised by John Hiley, Keith Brown, Ian McKenzie Smith, Electrical and Electronics Technology, Pearson Education Limited, New Delhi, 2007.	
2	Smarajit Ghosh, Fundamentals of Electrical and Electronics Engineering, Second Edition, PHI Learning, 2007.	
REFERENCE BOOKS:		
1	D.P.Kothari and I.J.Nagrath, Theory and Problems of Basic Electrical Engineering, PHI Learning., New Delhi.	
2	J.B.Gupta, A Course in Electrical Power, Katson Publishing House, New Delhi,	

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Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVG01	**BASIC PROGRAMMING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	To understand programming principles through visual programming
2	To explore Why Python and getting started Using Python
3	To learn Variables, Data Types and Expressions
4	To learn Conditional Code, Functions
5	To know the programming skills

THEORY

UNIT	TITLE	PERIODS
1	**PROGRAMMING PRINCIPLES THROUGH VISUAL PROGRAMMING**	**10**

Using visual programming (Scratch3, MIT) to explore principles of programming, control structures (if/then/else, loops - repeat, wait until, for, repeat until, forever, cloning), events (responding to keyboard, broadcast), motion and movement, animation looks and sounds, interactive gaming and sensing (user input, responding to mouse, callbacks), operators and variables.

UNIT	TITLE	PERIODS
2	**Why Python and getting started Using Python**	**11**

Motivation of learning Python, organizations and kinds of python and installation, basic Python console, IDE (Integrated Development Environments), Spyder installation and use.

UNIT	TITLE	PERIODS
3	**Variables, Data Types and Expressions**	**11**

Variables, Data Types (strings, numbers, lists, tuples, dictionaries), expressions with each of them, basic functions for Strings (concatenation, reverse, etc), numbers and functions available for numbers.

UNIT	TITLE	PERIODS
4	**Conditional Code**	**11**

Control and conditional code in Python boolean variables, if/else, if/elif/else, loops, range function, list comprehension, and conditional list comprehension

UNIT	TITLE	PERIODS
5	**Functions**	**11**

Creating functions for modularity and code reusability, generalization with input parameters to allow for code to be used in different situations.

	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to:		
CO1:	Programming principles through visual programming	
CO2:	Why python and getting started using python	
CO3:	Variables, data types and expressions	
CO4:	Conditional code	
CO5:	Functions	
TEXT BOOKS:		
1	Python Crash Course: A Hands-On, Project-Based Introduction to Programming (2nd Edition) Author: Eric Matthes. .	
2	Basic Python Programming for Beginners by Dr. Marlapalli Krishna & S. Jaya Prakash Dr. Marlapalli Krishna, K. Varada Rajkumar (Author)	
REFERENCE BOOKS:		
1	Programming with scratch: https://www.coursera.org/learn/programming-with-scratch	
2	Python for Everybody: https://www.coursera.org/specializations/python	

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGPGSH01	**ENGLISH - I**	**2**	**1**	**0**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
Course Objective	
1	To encourage the students to speak English
2	To enable students to use English in day-to-day communication
3	To build up their confidence in the usage of English
4	To expose them to light prose and poetry
5	To know the communication skills

THEORY

UNIT	TITLE	PERIODS
1	**Prose**	**10**

The Bet- Anton Chekhov - With The Photographer- Stephen Leacock The Portrait of a Lady- Khushwant Singh - On
The Face of It- Susan Hill - The Proposal- Anton Chekhov (Play)

UNIT	TITLE	PERIODS
2	**Poetry**	**11**

Say Not The Struggle Naught Availeth-Arthur Hugh Clough - Abu Ben Adhem -James Leigh Hunt
-Where the Mind is Without Fear- Rabindranath Tagore-Daffodils:
William Wordsworth-Stopping By Woods On A Snowy Evening-Robert Frost

UNIT	TITLE	PERIODS
3	**Spoken Communication**	**11**

Meeting People, Exchanging Greetings, Taking leave-Introducing Yourself- Introducing People To
Others-Answering The Phone And Asking For Others-Discussing Hobbies, Likes And Dislikes

UNIT	TITLE	PERIODS
4		**11**

Articles-Modal Auxiliaries-Prepositions

UNIT	TITLE	PERIODS
5	**Creating Compositions**	**11**

Report Writing-Summarizing

TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	Read and appreciate poems on their own.
CO2:	Analyze poetic texts using appropriate terms such as diction, tone, imagery, figures of speech, etc.
CO3:	Interpret a poem based on contextual evidence
CO4:	Analyze various types of novels and stories and pieces of prose with reference to the matics and other approaches.
CO5:	Read and comprehend better.
TEXT BOOKS:	
1	Hornby,A.S. Guide To Patterns And Usage In English(ELBS)
2	Corder,S.Pit An Intermediate English Practice Book(Orient Longman)
REFERENCE BOOKS:	
1	Vallins,G.D. Good English: How To Write It(ELBS)
2	Vallins,G.D Better English
3	Zandvoort A Handbook Of English Grammar(ELBS)
4	Wood,F.T. A Remedial English Grammar For Foreign Students

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH02	**APPLIED MATHEMATICS I**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	To understands Matrix theory, To develop the use of matrix algebra techniques for practical applications.
2	To understand mathematical tools needed in evaluating multiple integrals and their usage.
3	To make the students knowledgeable on effective mathematical tools for the solutions of differential equations that model physical processes
4	To understand the Basic on Analytical solid Geometry about Directional ratios and straight line
5	To make the students knowledgeable in the areas of direct and inverse functions of trigonometry.

THEORY

UNIT	TITLE	PERIODS
1	**MATRICES ITS APPLICATIONS**	**11**

Inverse and rank of a matrix, System of linear equations, Symmetric, Skew Symmetric and Orthogonal matrices, Eigen values and Eigenvectors of a real matrix, Characteristic equation, Properties of Eigenvalues. Cayley-Hamilton Theorem (statement only), Diagonalization of matrices.

UNIT	TITLE	PERIODS
2	**INTEGRAL CALCULUS**	**11**

Multiple Integral and its applications - change of order of integration. Applications: Areas (double integration) and volumes by triple integration (Cartesian and polar) – mass and center of mass (constant and variable densities)

UNIT	TITLE	PERIODS
3	**DIFFERENTIAL EQUATIONS**	**11**

Exact equations, First order linear equations, Bernoulli's equation, orthogonal trajectories, growth and decay, geometrical applications and electric circuits.

UNIT	TITLE	PERIODS
4	**ANALYTICAL SOLID GEOMETRY**	**11**

Directional cosines and ratios – angle between two lines – the equation of plane – equations to a straight line and shortest distance between two skew lines.

UNIT	TITLE	PERIODS
5	**TRIGONOMETRY**	10
Direct and inverse circular hyperbolic functions -logarithmic functions of a complex variable – Expansion of a trigonometric functions		
	TOTAL PERIODS:	54

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	The students will get knowledgeable on Matrix theory and develop the use of matrix algebra techniques for practical applications.
CO2:	Understanding mathematical tools needed in evaluating multiple integrals and their usage.
CO3:	The students grow their knowledgeable on effective mathematical tools for the solutions of differential equations that model physical processes
CO4:	Understanding the Basic on Analytical solid Geometry about Directional ratios and straight line
CO5:	Know about the areas of direct and inverse functions of trigonometry.
TEXT BOOKS:	
1	Dr.M.K. Venkataraman, Engineering Mathematics, Vol. (I,II), National Publishing Co., Madras,2009
2	S. Narayanan and T. K. Manicavachagom Pillay, Trigonometry, S. Viswanathan (Printers and Publishers) Pvt. Ltd., (1997)
REFERENCE BOOKS:	
1	N.P. Bali and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications, New Delhi , 2007.
2	Veerarajan T, Engineering Mathematics (I, II) , McGraw-Hill Education(India) Private Limited, 2015
3	Erwin Kreyszig, Advanced Engineering Mathematics (9 th Ed), John Wiley & Sons, New Delhi, 2011.
4	Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, Eleventh Reprint, 2010.
5	Bali N. and Goyal M., Advanced Engineering Mathematics, Laxmi Publications Pvt. Ltd., New Delhi, 9thEdition, 2011.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC02	**ENGINEERING DRAWING USING AUTOCAD (THEORY CUM PRACTICE)**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	To learn how to properly dimension and annotate engineering drawings as per standards of engineering drawing practice and Students learn the application of engineering graphics through computer-aided drafting.
2	To follow and understand the basics of engineering drawing with simple solids.
3	To properly apply and produce sectional views of some regular solids.
4	To properly create multi-view orthographic drawings from three dimensional diagrams.
5	To present a drawing in orthographic and isometric projections.

THEORY

UNIT	TITLE	PERIODS
1	**PROJECTION OF POINTS AND STRAIGHT LINES**	**14**

Reasons for implementing – CAD - Applications of CAD - Benefits/limitations of CAD - Hardware of CAD system, Types of CAD software. AutoCAD- Commands - Types of lines – Dimensioning - Theory of Projection – Elements of projection, planes of projection - methods of projection - Standards for Engineering Drawing practice.

Projection of points - projections of straight lines - various positions of straight lines with reference-to- reference planes, traces of lines.

UNIT	TITLE	PERIODS
2	**PROJECTION OF PLANES AND SOLIDS**	**14**

Projection of Planes – Types of planes - projection of planes - various positions of planes with reference- to reference planes (Use First angle method of projection).

Projection of Solids – Types of solids - projection of solids in simple position - projection of solids with axis inclined to one reference plane and parallel to other. (Use First angle method of projection).

UNIT	TITLE	PERIODS
3	**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES**	**14**

Section of solids – Regular solids prisms, cylinders, pyramids, cones and their parts. (Use First angle method of projection).

Development of surfaces of right, regular solids – development of prisms, cylinders, pyramids, cones and their parts.

UNIT	TITLE	PERIODS
4	**ORTHOGRAPHIC PROJECTION**	**15**

Orthographic Projection –Introduction to Orthographic projections - types of surfaces, invisible lines - precedence of lines - steps to draw orthographic views - orthographic projection of different objects. (Use First angle method of projection)

UNIT	TITLE	PERIODS
5	**ISOMETRIC PROJECTION**	**15**

Isometric projection – Theory of isometric projection - isometric view - isometric views from orthographic views for simple objects. (Use First angle method of projection).

TOTAL PERIODS:	**72**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	Learn to properly dimension and annotate engineering drawings as per standards of engineering drawing practice and Students learn the application of engineering graphics through computer-aided drafting.
CO2:	Follow and understand the basics of engineering drawing with simple solids.
CO3:	Properly apply and produce sectional views
CO4:	Properly create multi-view orthographic drawings from three dimensional diagrams.
CO5:	Present a drawing in orthographic and isometric projections.
TEXT BOOKS:	
1	N.D. Bhatt, Engineering Drawing, 49th edition, Charotar Publishing House, 2014.
2	K.Venugopal, Engineering Drawing & Graphics + Auto CAD, 4th Edition New Age Publications, New Delhi.
REFERENCE BOOKS:	
1	K.R. Gopalakrishna and Sudhir Gopalakrishna, Engineering Graphics, Inzinc Publishers, 2007.
2	Dhananjay A Jolhe,Tata , Engineering Drawing with an introduction to AutoCAD, McGraw-Hill Publishing company limited
3	D. M. Kulkarni, A. P. Rastogi and A.K.Sarkar; Engineering Graphics with AutoCAD, PHI Learning Private Limited, New Delhi, 2009.

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC03	**BASIC ELECTRICAL AND ELECTRONICS LAB**	**0**	**0**	**8**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

LIST OF EXPERIMENTS:

1. Study of tools and accessories
2. Study of joints
3. Staircase wiring
4. House wiring
5. Energy meter connection single phase and three phase system
6. Tube Light and Fan connection
7. Two way switch connection
8. Ceiling fan coil winding
9. Load calculation
10. Back up and capacity calculation of inverter

ELECTRONICS LAB

1. Rectifiers Construction of half wave and full wave rectifiers with and without filters – Calculation of ripple factors.
2. Frequency Response of RC Coupled Amplifiers Determination of frequency response of given RC coupled amplifier - Calculation of bandwidth.
3. Verification of Kirchoff's Voltage and Current Laws Determine the voltage and current in given circuits using Kirchoff's laws theoretically and verifies the laws experimentally.
4. Study of CRO
5. VI characteristics of MOSFET and IGBT
6. Characteristics of transistor in CB, CE, CC configurations
7. Measurement of AC and DC voltages
8. Frequency and phase measurements (usingLissajou's figures)

TOTAL PERIODS :	**144**

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVG02	**PROGRAMMING LAB**	**0**	**0**	**6**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
Course Objective	
1	To learn principles of basic programming and interactive programming with a visual programming language like Scratch 3 (MIT).
2	To become comfortable doing small projects in scratch 3.
3	To learn key principles of interactive programming and creating games and problem solving tasks
4	To learn the various ways to run the program on Windows, and Linux. Suggested editors and integrated development environment
5	To learn to work with various data types including string, list, tuples, dictionaries, boolean and more. How to use variables based on the requirement
6	To control way of flow your program, create a own modules and define and use functions
7	Important built-in Python functions that you'll use often.

THEORY

UNIT	TITLE	PERIODS
1	**Introduction to Scratch, Events, control, sensing**	**22**

Sprites, stage, blocks, saving and loading projects, using mouse. Sprite options - code, costume, sound, background options - code, backdrop, sounds. Basic events, control Challenge: Sory book with backdrop change or magic show.
Advanced Events, control, sensing of different types, basic operators Challenge: Interactive Q & A game, Make a maze game

UNIT	TITLE	PERIODS
2	**Logo turtle, Blocks, variables, Lists and operators**	**21**

Drawing with the pen and making different kinds of shapes Challenge: Mandalas with scratch. Blocks help avoid repeat code and take parameters, variables help generalize code and add memory functionality, use of random number generator Challenge: Add scores to earlier programs, reduce lines of code with blocks, generalize Q & A e.g. cube root of a number questions generated on their own.
Advanced operators and lists to remember sequence of data and its processing Challenge: Enter a list of names 10 names and the program tests you to tell them backwards. Given an angle program calculates the cosine of the angle in degrees/radians.

UNIT	TITLE	PERIODS
3	**Python Setup, String and Variable, Number and Math**	**22**

Setup environment path variable, Command prompt, indentation, help, Immutable object, and non-immutable object, String Concatenation, Format string, String Operation
Numbers, Numeric Operations, Numeric Functions, Mathematical functions

UNIT	TITLE	PERIODS
4	**Boolean and Conditionals, Function and Method,**	**22**
	Error Handling	
Basic Function syntax, calling a function, built-in function, user defined function(UDF),Anonymous Function, Method, Try Catch		
UNIT	**TITLE**	**PERIODS**
5	**List and Dictionaries, Tuples, Files**	**21**
Slices, Loops, Sorting and Range, Create a list of dictionaries, Access key, and pair values, Update key, Append a Dictionary		
	TOTAL PERIODS:	**108**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Learn principles of basic programming and interactive programming with a Visual programming language like Scratch 3 (MIT).	
CO2:	become comfortable doing small projects in scratch 3	
CO3:	learn key principles of interactive programming and creating games and problem solving tasks	
CO4:	understand Object-oriented programming skills in Python	
CO5:	Skill to develop application with real time application	
CO6:	Ability work in advance programming skills in python	
CO7:	The fundamentals of how to store, retrieve, and process data efficiently.	
TEXT BOOKS:		
1	Michael H Goldwasser, David Letscher, “Object Oriented Programming in Python”, Prentice Hall, 1st Edition, 2007.	
2	YashavantKanetkar, Aditya Kanetkar, “Let us Python”, BPB publication, 1st Edition, 2019	
REFERENCE BOOKS:		
1	Coursera: Programing with Scratch	
2	Challenges to learn scratch https://www.auraauro.com/learn/learn-scratch/	
3	Ashok Kamthane, Amit Kamthane, “Programming and Problem Solving with Python”, McGraw Hill Education (India) Private Limited, 2018.	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH03	**APPLIED PHYSICS – I (THEORY CUM PRACTICE)**	**2**	**0**	**2**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To explain the fundamentals of elastic properties of solids.
2.	To understand the motion of waves and application of acoustics
3.	To learn to interpret and model physical phenomena using calculus
4.	To provide comprehensive knowledge and understanding of electricity and its applications
5.	To learn atomic and molecular physics and explain the macro physical phenomenon with it
6.	To acquire knowledge on fundamentals of physics and its applications in production and energy technologies

THEORY

UNIT	TITLE	PERIODS
1	**PROPERTIES OF MATTER**	**14**

Elasticity –- Hooke's law – Elastic moduli – Poisson's ratio – Beams – bending of beams – Expression for bending moment – Theory of uniform and non – uniform bending - Young's modulus - Koenig's method – Bernoulli s Theorem – Applications Viscosity- Co-efficient of Viscosity-Poiseuille's formula for co efficient of viscosity of a liquid- Stokes law-determination of viscosity-surface tension-molecular interpretation-Drop weight method

UNIT	TITLE	PERIODS
2	**WAVES MOTION AND APPLIED ACOUSTICS**	**14**

Waves Motion- General Transverse waves on a string, Travelling and standing waves on a string. Normal Modes of a string- Group velocity. Phase Velocity, Plane waves, Spherical waves. Wave intensity, Applied Acoustics, Intensity and loudness of sound- Decibels - Intensity levels – musical notes – musical scale- Acoustics of buildings. Reverberation and time of reverberation- Absorption coefficient

UNIT	TITLE	PERIODS
3	**INTERPRET AND MODEL PHYSICAL PHENOMENON WITH CALCULUS**	**15**

Rates and derivatives, straight-line kinematics - relationship between distance, speed, andacceleration. Integration to work backwards from acceleration, speed and distance. Description of the distance covered of a falling object as a function of time. Being able to draw this visually. Potential

UNIT	TITLE	PERIODS
4	**ELECTRICITY AND ELECTROMAGNETISM**	**14**

Charges, laws of electrostatics - Coulomb's law, Gauss's law, the electric field/force of a point charge (positive and negative), integrating along an electric line of force to get voltage, line of charge, plate ofcharge, relating to energy stored in a charge of a capacitor. Deriving the same with Gauss law.

UNIT	TITLE	PERIODS
5	**ATOMIC AND MOLECULAR PHYSICS**	15
Atomic picture of matter, atoms as building blocks. Using atoms to understand - everyday phenomena- air pressure, dynamic equilibrium, states of matter, melting and boiling point, things expand onheating, evaporation, diffusion, sound.		
	TOTAL PERIODS:	72
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	The basics of Properties of matter	
CO2:	The fundamentals of Waves motion and applied acoustics	
CO3:	The Interpret and model physical phenomenon with calculus	
CO4:	About Electricity and electromagnetism	
CO5:	The basics of Atomic and molecular physics	
TEXT BOOKS:		
1.	Narayan Rao, (1998), B V, First Year B. Sc. Physics, New Age International (P) Lt. Supplementary Readings: 1. Halliday, D, Resnick R and Walker J, (2011), Fundamentals of Physics, Wiley India, Pvt Ltd.	
2.	Mathur, D S (2002), Mechanics, S. Chand & Co.,	
REFERENCE BOOKS:		
1.	Mathur, D S (2002), Properties of matter, S. Chand & Co.,	
2.	Brijlal and Subramanian, (2006), Properties of matter, S. Chand & Co.,	
3.	Rai, G D, Solar energy utilization, Khanna Publishers.	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH04	**Integral Yoga & Values-based Life and Leadership for Human Unity- I**	**1**	**0**	**4**	**0**	**3**
PREREQUISITES:						
NIL / Course Code – Course Title / Topics						
Course Objective						
1	To understand and analyze the evolutionary steps of nature and man					
2	To explore different systems of yoga and their significance and limitations and understand the synthesis in Integral Yoga in its essence					
3	To learn Radical Transformational Leadership tools and distinctions and to apply what I stand for (care about) in my everyday practice.					
4	To learn systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment with universal values.					
THEORY						
UNIT	**TITLE**					**PERIODS**
1	**Introduction to Yoga**					**6**
Meaning & relevance of yoga in human life; Fundamentals of yoga						
UNIT	**TITLE**					**PERIODS**
2	**Evolution: Progressive self-manifestation of Nature in man**					**6**
Bodily life, mental life, beyond mental life: higher life; Planes of consciousness; Involution						
UNIT	**TITLE**					**PERIODS**
3	**Integral Yoga**					**6**
Introduction to parts of the being, Aim of Integral Yoga						
	TITLE					**PERIODS**
LABORATORY						**72**
(I) Sourcing inner capacities (ii) My Four Profiles (iii) Distinction: Courage and Bravery (iv) Background Conversations & Listening (v) Watch 12 Angry Men and listing leadership traits (vi) "You are my Hero" Noticing & Transforming disempowering cultural norms. Read book; discuss in Pairs. (vii) Systems principles-Film: Story of Stuff (viii) Architecture for Equitable Change: Partial & Conscious-Full Spectrum Response Model (ix) Designing my breakthrough Initiative using CFSR (x) Designing my breakthrough Initiative---Beyond Problem-solving--Realise & respond (xi) Background Conversations & Leadership (xii) Speaking powerfully to inspiring others to commit to action— speaking about my BTI (xiii) Giving feedback to foster growth (xiv) Complaints as a commitment for action						
						TOTAL PERIODS: **90**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	Be able to explain the evolutionary steps of nature and man
CO2:	To know different systems of yoga and their significance and limitations and understand the synthesis in Integral Yoga in its essence
CO3:	To apply Radical Transformational Leadership tools and distinctions and to apply what I stand for (care about) in my everyday life.
CO4:	To use systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment with universal values.
REFERENCE COURSES/BOOKS:	
1	Sri Aurobindo. Synthesis of Yoga.
2	Indian Psychology Institute. https://infinityinadrop.net/infinityfiles/0-4-3-evo-longterm.php
3	Indian Psychology Institute. https://infinityinadrop.net/infinityfiles/0-3-1d-cons-integral.php
4	Monica Sharma. (2017). Radical Transformational Leadership: Strategic Action for Change, North Atlantic Publishing, at Berkeley, California

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC04	**INTRODUCTION TO RENEWABLE ENERGY SOURCES**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To know the fundamentals of Energy Resources & Environmental Impact
2.	To learn about basics of Solar Energy
3.	To learn about basics of Wind Energy
4.	To know about bio energy basics
5.	To learn the fundamentals of Renewable energy conversion techniques

THEORY

UNIT	TITLE	PERIODS
1	**Energy Resources & Environmental Impact**	**14**

Introduction to the nexus between energy, environmental sustainable development, Energy sources overview and classification, sun as the source of energy, fossil fuel reserves and resources-overview of global/India's energy scenario . Energy consumption models–Specific Energy Consumption

UNIT	TITLE	PERIODS
2	**Solar Energy**	**15**

Solar radiation: measurements and prediction. Indian's solar energy potential and challenges, solar energy conversion principles and technologies: Photosynthesis, Photovoltaic conversion and Photo thermal energy conversion

UNIT	TITLE	PERIODS
3	**Wind Energy**	**14**

Atmospheric circulations, atmospheric boundary layers, classification, factors influencing wind, wind shear, turbulence, wind energy basics and power Content, wind speed monitoring, Betz limit, wind energy conversion system: classification, characteristics and applications.

UNIT	TITLE	PERIODS
4	**Bioenergy**	**15**

Biomass as energy resources; bio-energy potential and challenges, Classification and estimation of biomass; Source and characteristics of biofuels: Biodiesel, Bioethanol, Biogas. Types of biomass energy conversion systems-waste to energy conversion technologies

UNIT	TITLE	PERIODS
5	**Renewable energy conversion techniques**	**14**

Thermochemical Conversion -Basic aspects of biomass combustion - heat of combustion - different types of grates - Co combustion of biomass – Gasification - Fixed and Fluidized bed gasifier - Gasification technologies for the selected waste like Rice Husk, Coir pith, Bagasse, Poultry litter etc., - Pyrolysis

	TOTAL PERIODS:	**72**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Know the fundamentals of Energy Resources & Environmental Impact	
CO2:	Know the fundamentals of Solar Energy	
CO3:	Know the fundamentals of Renewable energy conversion techniques	
CO4:	Know the fundamentals of Wind energy system	
CO5:	Know the fundamentals of Bio gas energy system	
TEXT BOOKS:		
1.	Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean- Philippe; Zaccour, Georges (Eds.), 2005	
2.	Energy and the Environment, Ristinen, RobertA. Kraushaar,JackJ. A Kraushaar, JackP. Ristinen, RobertA., 2nd Edition,John Wiley, 2006	
REFERENCE BOOKS:		
1.	Solar Energy: principles of Thermal Collection and Storage,S.P.Sukhatme, TataMcGraw-Hill (1984).	
2.	Wind Energy Conversion Systems, L.L. Freris, Prentice Hal1990	
3.	Energy Scenario& Renewable Energy Resources	

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGPGSH05	**ENGLISH - II**	**2**	**1**	**0**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
Course Objective	
1.	To encourage the students to speak English
2.	To enable students to use English in day-to-day communication
3.	To build up their confidence in the usage of English
4.	To expose them to light prose and poetry
5.	To develop their written and communicative competence

THEORY

UNIT	TITLE	PERIODS
1	**Prose**	**11**
How much Land Does A Man Need: Leo Tolstoy-Penalty: Premchand -The Painter Of Signs: R K Narayan-Arms And The Man: George Bernard Shaw (Play)		
UNIT	**TITLE**	**PERIODS**
2	**Poetry**	**10**
Do Not Go Gentle Into That Good Night: Dylan Thomas-If : Rudyard Kipling-Ozymandias: Percy Bysshe Shelley-Ode To Autumn: John Keats-The Dungeon: Samuel Taylor Coleridge		
UNIT	**TITLE**	**PERIODS**
3	**Spoken Communication**	**11**
The Art Of Public Speaking-Ability To Explain A Topic To Your Peers-Ability To understand Native Speakers And Repeat Sentences		
UNIT	**TITLE**	**PERIODS**
4	**Grammar And Vocabulary**	**11**
Tenses, punctuation ,voices		
UNIT	**TITLE**	**PERIODS**
5	**Creating Compositions**	**11**
Essay Writing-Formal Letter Writing		
	TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to know:	
CO1:	Read and appreciate poems on their own.
CO2:	Analyze poetic texts using appropriate terms such as diction, tone, imagery, figures of speech, etc.
CO3:	Interpret a poem based on contextual evidence
CO4:	Analyze various types of novels and stories and pieces of prose with reference to thematics and other approaches
CO5:	Read and comprehend better

CO6:	Communicate in English orally and in writing
CO7:	Refer to the dictionary for synonymous expressions and grammar
CO8:	Enlarge the vocabulary and understand the structure of sentences and grasp the idea of the author
TEXT BOOKS:	
1.	Hornby,A.S. Guide To Patterns And Usage In English(ELBS)
2.	Corder,S.Pit An Intermediate English Practice Book(Orient Longman)
REFERENCE BOOKS:	
1.	Vallins,G.D. Good English: How To Write It(ELBS)
2.	Vallins,G.D Better English
3.	Zandvoort A Handbook Of English Grammar(ELBS)
4.	Wood,F.T. A Remedial English Grammar For Foreign Students
5.	Dowling, Dave Oxford Guide To Effective Writing And Speaking

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH06	**APPLIED MATHEMATICS II**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	To introduce Laplace transform, useful technique for solving many application problems and also to solve differential and integral equations.
2	To introduce students to use numerical methods and techniques for solving the problems
3	To create awareness about optimization in utilization of resources and Optimization Problem and apply operations research techniques to industrial operation
4	To introduce students to use network analysis and techniques for effective
5	To understand basic statistics and distributions

THEORY

UNIT	TITLE	PERIODS
1	**LAPLACE TRANSFORM AND ITS APPLICATIONS**	**11**

Definition, Transforms of elementary functions, properties. Transform of derivatives and integrals. Multiplication by t and division by t. Transform of unit step function, transform of periodic functions. Initial and final value theorems. Methods for determining inverse Laplace transforms, convolution theorem, Application to differential equations and integral equations. Evaluation of integral by Laplace transforms.

UNIT	TITLE	PERIODS
2	**NUMERICAL METHODS**	**11**

Numerical solution of algebraic and transcendental equations – Bolzono's bisection method – Successive approximation method – Regula falsi method – Newton Raphson method – Numerical solution of simultaneous linear algebraic equations – Gauss elimination method – Gauss Jordan elimination method – Gauss seidel iteration method.

UNIT	TITLE	PERIODS
3	**OPERATIONS RESEARCH**	**11**

Transportation Problem - Assignment Problem – Travelling salesman problem. Replacement problem – Replacement of items that deteriorate with time – Replacement of items that fail completely.

UNIT	TITLE	PERIODS
4	**NETWORK ANALYSIS**	**11**

Introduction to Network –Basic concepts – Construction of network diagram. Project Management: Introduction – Critical path method – Critical path determination – Optimal scheduling by CPM – PERT.

UNIT	TITLE	PERIODS
5	**PROBABILITY AND STATISTICS**	10
Probability, Events, Sample space, Axioms of probability, Random variable (Discrete and Continuous), Expectation, Probability Distribution: Binomial, Poisson & Normal distribution and statistical parameters of these distributions, Correlation and Regression, Rank correlation.		
	TOTAL PERIODS:	54

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	Knowing about Laplace transform, useful technique for solving many application problems and also to solve differential and integral equations.
CO2:	Students will use numerical methods and techniques for solving the problems
CO3:	Students gets awareness about optimization in utilization of resources and Understanding Optimization Problem and apply operations research techniques to industrial operation
CO4:	Students will use network analysis and techniques for effective
CO5:	Understanding basic statistics and distributions
TEXT BOOKS:	
1	M.K. Venkataraman, Engineering Mathematics, Vol. II, National Publishing Co., Madras, 2009
2	Numerical methods in Science and Engineering, M.K.Venkataraman, National Publishing co, Chennai 2001.
3	Operations Research, Kanti Swarup, P.K.Gupta and Man Mohan, S.Chand Publishers 1991.
4	Introductory of operations research theory and applications by H. S. Kasana & Kumar, Springer 2007
5	S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, 10th Edition, Sultan Chand &Sons, New Delhi, 2000.
REFERENCE BOOKS:	
1	Veerarajan T, Engineering Mathematics II, McGraw-Hill Education(India) Private Limited, 2014
2	S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India Private Ltd, New Delhi.3rd Edition, 2000
3	Resource Management Techniques(Operations Research) by V.Sundaresan, K. S. Ganapathy Subramanian, K. Ganesan – A. R.Publications
4	Erwin Kreyszig, Advanced Engineering Mathematics (9 th Ed), John Wiley & Sons, New Delhi, 2011.
5	B. S. Grewal, : Higher Engineering Mathematics, Khanna Publishers, New-Delhi, 2008.
6	N.P. Bali & Manish Goyal: A text book of Engineering Mathematics, Laxmi Publications, New Delhi, 2008.

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGPGSH07	**APPLIED PHYSICS - II**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To understand the basic crystal structures and diffraction types of bondings.
2.	To learn the thermodynamic system and its laws.
3.	To understand the fundamental principles of semiconductors
4.	To study the basic principle of laser and its production for different types of application
5.	Gives the Knowledge of Conventional and non-conventional energy sources

THEORY

UNIT	TITLE	PERIODS
1	**CRYSTALS STRUCTURE**	**10**

Crystal Structure, bonding and properties -Crystal Lattice - Primitive and unit cell - seven classes of crystal - Bravais Lattice - Miller Indices - Structure of crystals - Simple cubic, Face centered cubic, Body centered cubic and Hexagonal close packed structure Types of bonds in crystals - Ionic, covalent, Metallic, Vander Waal's and Hydrogen Bonding

UNIT	TITLE	PERIODS
2	**THERMODYNAMICS**	**11**

Thermodynamic system - Zeroth law, First and Second law of thermodynamics – Isothermal and Adiabatic Process -Carnot engine- working and efficiency - Carnot's theorem - Thermodynamic scale of temperature – Clausius and KelvinStatement - Third law of thermodynamics - Entropy - Change in entropy in a reversible/ irreversible process – Application of heat and Thermodynamics

UNIT	TITLE	PERIODS
3	**SEMICONDUCTOR PHYSICS**	**11**

Intrinsic semiconductors – p and n doping - Carrier concentration and dependence on temperature PN junction theory - V-I characteristics of a PN junction diode - Half wave rectifier - Full wave rectifier -Bridge rectifier - Efficiency - filters - capacitor filter- choke input filter- pi filter - Zener diode - equivalent circuit - voltage regulator - LED - V-I characteristics – advantages - applications - photo diode - characteristics - applications

UNIT	TITLE	PERIODS
4	**LASER PHYSICS AND ITS APPLICATION**	**11**

Spontaneous emission – Stimulated absorption and emission – Meta stable state –Population inversion – Pumping – types of pumping- main parts of Laser-principle of Laser
Production of LASER – Solid State Lasers – Ruby Lasers - Nd : YAG laser – Gas lasers – Helium – Neon laser – CO2 laser – Semiconductor lasers – Diode laser
Applications of LASER in cutting – Welding – Drilling – Hologram –material processing, Medicineand Communication

UNIT	TITLE	PERIODS
5	**ENERGY SOURCES AND ITS APPLICATION**	**11**
Kinds of energy – Mechanical energy, Thermal energy, Electrical energy, atomic and nuclear energy, (Examples) – Conservation of energy – work energy theorem. World's reserve of Commercial energy sources and their availability - India's production and reserves - Conventional and non - conventional sources of energy, comparison – Coal - Oil and natural gas –applications - merits and demerits. Photovoltaic systems (PV)- principle and applications in Powered fan – powered area - lighting system		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Crystal structures and diffraction types of bondings.	
CO2:	Thermodynamic system and its laws.	
CO3:	The fundamental principles of semiconductors	
CO4:	Principle of laser and its production for different types of application	
CO5:	Conventional and non-conventional energy sources	
TEXT BOOKS:		
1.	Kittel, (2003), Introduction to Solid State Physics, Willey Eastern Ltd.	
2.	Brij Lal and N Subrahmanyam (2016), Heat Thermodynamics S Chand & CompanyPvt Ltd, New Delhi.	
3.	Pillai, S.O. (2002), Solid State Physics New Age International (P) Ltd.	
4.	Murugeshan R. and KiruthigaSivaprasath (2016) Modern Physics, S. Chand &CO.Ltd, New Delhi,	
5.	Theraja, B.L. (2016), Modern Physics, S. Chand & CO Ltd, New Delhi	
REFERENCE BOOKS:		
1.	Raghavan, V. (2004), Materials Science and Engineering, Prentice Hall of India PrivateLimited, New Delhi	
2.	Rajaram J B (1990), Heat and thermodynamics, S Chand & Co., New Delhi.	
3.	Lasers Fundamentals and Applications, K. Thyagarajan, AjoyGhatak, Springer Science & BusinessMedia, 2010	
4.	Kalogirou S.A., 2013, Solar Energy Engineering: Processes and Systems, 2nd Edition, Academic Press.	
5.	Zobaa A. F and Ramesh Bansal, 2011, Handbook of Renewable Energy Technology, World Scientific	

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC05	**BASIC RENEWABLE ENERGY LAB**	**0**	**0**	**8**	**0**	**4**
PREREQUISITES:						
NIL / Course Code – Course Title / Topics						
LIST OF EXPERIMENTS:						
1. Simulation study on Solar PV Energy System. 2. Experiment on "VI-Characteristics and Efficiency of 1kWp Solar PV System". 3. Experiment on "Shadowing effect &diode based solution in1kWp Solar PV system". MPPT applications 4. Experiment on Performance assessment of Grid connected and Standalone 1kWp Solar Power System. 5. Simulation study on Wind Energy Generator. 6. Assemble micro Wind Energy Generator. 7. Simulation study on Hybrid (Solar-Wind) Power System. 8. Experiment on Performance Assessment of Hybrid (Solar-Wind) Power System. 9. Simulation study on Hydel Power. 10. Experiment on Performance Assessment of 100W Fuel cell.						
TOTAL PERIODS :	**90**					

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH08	**Integral Yoga & Values-based Life and Leadership for Human Unity- I Refresher and Application**	**1**	**0**	**4**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
COURSE OBJECTIVES:	
1	To incorporate aspects of integral yoga into life with meditation and reflection
2	To incorporate aspects of integral yoga into life with suryanamaskar
3	To integrate Radical Transformational Leadership tools in everyday practice.
4	To design projects for system and cultural shift from universal values
5	To learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

THEORY

UNIT	TITLE	PERIODS
1	**Review of Integral Yoga Principles**	**9**
Review Integral Yoga - physical, mental, vital alignment with psychic		
UNIT	**TITLE**	**PERIODS**
2	**RTL (Radical Transformational Leadership) Book Reading**	**9**
Understanding the praxis around the world around RTL		
	TITLE	**PERIODS**
LABORATORY		**72**
To learn and incorporate daily meditation To learn and incorporate suryanamaskar To reflect weekly on the progress made physically and mentally Reflection on the tools applied in day to day life. Conversations for clarity and refreshers. Refresher on design templates and design and refining the breakthrough initiative at college.		
	TOTAL PERIODS	**90**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
1	Develop in meditation and reflection
2	Develop physically through suryanamaskar
3	Use Radical Transformational Leadership tools in everyday practice.
4	Design projects for system and cultural shift from universal values
5	Notice distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

REFERENCE COURSES/BOOKS:

1	Altered Traits: Science Reveals How Meditation Changes Your Mind, Brain, and Body- Daniel Goleman and Richard Davidson
2	Monica Sharma. (2017). Radical Transformational Leadership: Strategic Action for Change, North Atlantic Publishing, at Berkeley, California

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC06	**BATTERIES TECHNOLOGY**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To know the fundamentals of Primary & Secondary Batteries,
2.	To learn about Lead Acid Battery and its working
3.	To know the fundamentals of Lithium-ion Battery
4.	To learn about Thermal management of battery system
5.	To know the fundamentals of battery connections

THEORY

UNIT	TITLE	PERIODS
1	**Introduction**	**14**

Electrochemical cell, electro motive force, free energy changes and EMF, concentration of the reactants on EMF, effect of cell temperature, derivation of number of electrons involved in a cell reactions, thermodynamic calculations, electrochemical series-equilibrium potential, Nernst equation-Battery types – primary and secondary batteries and examples - theoretical voltage, capacity, energy & specific energy, power & specific power.

UNIT	TITLE	PERIODS
2	**Primary & Secondary Batteries**	**14**

Dry cells-zinc/carbon battery, alkaline primary batteries, Zn/air, Lithium batteries, reserve batteries: principle, components, construction, characteristics, applications, and problems associated with the systems.

Principle, construction, components, merits and demerits of lead acid, nickel-cadmium, nickel-metal hydride, lithium-ion batteries-Possible applications

UNIT	TITLE	PERIODS
3	**Lead Acid Battery**	**15**

Advantages and disadvantages of lead acid batteries, electrochemical reactions, physical and chemical properties of active materials, characteristics and properties of sulphuric acid, constructional features, materials and manufacturing methods, SLI (Automotive) batteries, charge and discharge properties of lead acid batteries, sealed lead acid or maintenance free batteries fabrication technology and testing. Lead acid battery for PV and automotive applications

UNIT	TITLE	PERIODS
4	**Lithium-ion Battery**	**14**

Advanced anodes and cathodes – theoretical capacity – merits and demerits – Nano materials for anodes: carbon nano tubes, graphene, Sn, Al, Si, SnO_2, NiO, TiO_2& $LiTiO_4$. Nano materials for cathodes: $LiCoO_2$, $LiMn_2O_4$, $LiFePO_4$, and doped cathodes. Fabrication of nano structured $LiCoO_2$, $LiMn_2O_4$, $LiFePO_4$, Si, Sn and CNTs. Battery fabrication technology and testing, batteries for electric vehicles, hybrid vehicles and solar photovoltaic applications

UNIT	TITLE	PERIODS
5	**Thermal management of battery system**	**15**
Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system, Battery Management System: Definition, Parts: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests. Battery management – Recycling of battery materials. Design and sizing of batteries for various application - E-mobility.		
	TOTAL PERIODS:	**72**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Know the fundamentals of Primary & Secondary Batteries,	
CO2:	To learn about Lead Acid Battery	
CO3:	The working principles of Lithium-ion Battery	
CO4:	Troubleshoot the Thermal management of battery system	
CO5:	Know the fundamentals of battery connections	
TEXT BOOKS:		
1.	Barak, Electrochemical Power sources, I.E.E. series Peter Peregrinus Ltd. Steverage, U.K 1980 reprint 1997.	
2.	J.O.M. Bockris& A.K.N. Reddy, Modern Electrochemistry, Plenum Press, 1996.	
REFERENCE BOOKS:		
1.	A.J. Bard & L.R. Faulkner, Electrochemical Methods Fundamentals and Applications, John Wiley & Sons. 2nd Edition, 2001	
2.	B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.	
3.	T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC07	SOLAR PHOTOVOLTAIC TECHNOLOGY	4	0	0	0	4

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn Semiconductors for Solar Cell,
2.	To know about Device fabrication
3.	To learn Characterization and Analysis
4.	To know the fundamentals of Troubleshooting & maintenance of solar system
5.	To learn about solar system and its working

THEORY

UNIT	TITLE	PERIODS
1	**Properties of Semiconductor**	14

Semiconductors-crystals structures, atomic bonding, energy band diagram–direct & indirect band gap- p& n doping and carrier concentration-Hall Effect in semiconductors–Intrinsic & extrinsic semiconductor –compound semiconductors-diffusion and drift of carriers, continuity equation – optical absorption– carrier recombination-Effect of temperature.

UNIT	TITLE	PERIODS
2	**Semiconductors for Solar Cell**	14

Silicon: preparation of metallurgical, electronic and solar grade Silicon- Production of single crystal Silicon: Czokralski(CZ) and Float Zone(FZ) method–imperfections–carrier doping and lifetime- Germanium- compound semiconductors: growth & characterization- amorphous materials – Transparent conducting oxides-Anti-reflection principles and coatings – organic materials

UNIT	TITLE	PERIODS
3	**Device fabrication**	14

Semiconductor junctions: Schottky barriers, MIS, P-N junction, p-i-n junction and its properties Homo & hetero junction solar cells, multi junction solar cells-Fabrication techniques: Diffusion, thin film technology-physicalvapourdeposition(PVD)-Electro-deposition-Molecular beam epitaxy (MBE) - Metal organic chemical vapour deposition(MOCVD)-Plasma enhanced chemical vapour deposition(PECVD)- Organic and Nanotech solar cells–contact & grid metallization.

UNIT	TITLE	PERIODS
4	**Characterization and Analysis**	15

Device isolation & analysis-Ideal cell under illumination- solar cell parameters short circuit current, open circuit voltage, fill factor, efficiency; optical losses; electrical losses, surface recombination velocity, quantum efficiency-measurements of solar cell parameters; I-V curve & L-I-V characteristics, internal Quantum yield measurements– Effects of series and parallel resistance and Temperature -Loss analysis.

UNIT	TITLE	PERIODS
5	**Troubleshooting & maintenance of solar system**	15
System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, Other common problems, Inverter topologies, High Efficiency on-grid inverters,		
	TOTAL PERIODS:	72
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Know about Semiconductors for Solar Cell,	
CO2:	The fundamentals of Device fabrication	
CO3:	The Characterization and Analysis	
CO4:	About Troubleshooting & maintenance of solar system	
CO5:	The fundamentals of solar system working	
TEXT BOOKS:		
1.	Semiconductors for solar cells, H.J. Moller, ArtechHouseInc, MA, USA, 1993.	
2.	Fundamentals of Solar Cells:PV Solar Energy Conversion, Alan L FahrenbruchandRichardH Bube , Academic Press, New York, 1983	
REFERENCE BOOKS:		
1.	Solar Cells and their Applications, LarryDPartain(ed.),JohnWileyandSons,Inc,NewYork,1995.	
2.	J. Nelson,The physics of solar cells, Imperial College Press, 2006.	
3.	Photovoltaic Materials, Richard H Bube, Imperial College Press,1998	

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVG03	**ELECTRICAL MACHINES**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn the fundamentals of Magnetic circuits and transformer
2.	To learn about Electro mechanical energy conversion
3.	To learn the working principles of Dc generator
4.	To learn the working principles of dc motor
5.	To know the various applications in electrical machines

THEORY

UNIT	TITLE	PERIODS
1	**MAGNETIC CIRCUITS AND TRANSFORMER**	**10**

Simple magnetic circuit calculations– Single phase transformers – Principle-Construction – No load operation – Ideal transformer-Vector diagram- no load and on load -Equivalent circuit – Testing-Losses — Efficiency, voltage regulation and all day efficiency- Parallel operation and load of single-phase transformers-Applications. Auto-transformer construction and saving in copper

UNIT	TITLE	PERIODS
2	**POLYPHASE TRANSFORMER**	**11**

Three phase transformers – Principle - Construction - Poly phase connections – Star, Zigzag, Open-delta, Scott connection, Le Blanc connection-three-phase to single phase conversion – Testing and parallel operation - On load tap changing; Special transformers variable frequency transformer (VFT), pulse transformer, high frequency transformer

UNIT	TITLE	PERIODS
3	**ELECTRO MECHANICAL ENERGY CONVERSION**	**11**

Principles of electro mechanical energy conversion – Energy, Co-energy – Forces of electromagnetic origin – Single and multiple excited magnetic field system – Elementary concepts of rotating machines –EMF of distributed winding - Rotating magnetic field – Torque – Magnetic Leakage

UNIT	TITLE	PERIODS
4	**DC GENERATOR**	**11**

DC Generator- Construction – Lap and wave winding – EMF equation-excitation and types of generators- Characteristics - armature reaction-methods of improving commutation- testing power flow diagram-Applications

UNIT	TITLE	PERIODS
5	**DC MOTOR**	11
DC Motor-torque equation – types-back EMF and voltage equations- characteristics - Starting Speed control- testing-direct, indirect and regenerative tests-Power flow and efficiency separation of losses-retardation test- Braking - DC machines dynamics; Introduction to solid state power control of DC machines		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	the fundamentals of Magnetic circuits and transformer	
CO2:	about Electro mechanical energy conversion	
CO3:	the working principles of Dc generator	
CO4:	the working principles of dc motor	
CO5:	the various applications in electrical machines	
TEXT BOOKS:		
1.	J. Nagrath and D.P. Kothari, "Electric machines" T.M.H. publishing Co.Ltd., New Delhi, 3rd Edition, 2005	
2.	B.L. Theraja, "Electrical Technology Vol.II AC/DC Machines", S. Chand, 2008	
REFERENCE BOOKS:		
1.	Chapman, S. J. 1999. Electric Machinery Fundamentals. New York: McGraw-Hill.	
2.	Clayton, A. E. and N. H. Hancock 1962. Performance and Design of DC Machines. London: ELBS Pitman Edn.	
3.	Draper, A. 1967. Electric Machines. London: Longman	

Course Code	Course Title	Periods per week				Credits
	HINDI I	**L**	**T**	**P**	**R**	
BVGPGSH09		**3**	**0**	**0**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
Course Objective	
1	To introduce the students to Hindi Alphabet and To encourage the students to speak Hindi
2	To enable students to use Hindi in day-to-day communication
3	To build up their confidence in the usage of Hindi
4	To expose them to light poetry
5	To introduce them to the basics of tenses

THEORY

UNIT	**TITLE**	**PERIODS**
1	**Basic Alphabets**	**11**
Vowels-Consonants: Vocal Tract-Consonants: Voicing & Aspiration-Hindī Consonants 1-Hindī Consonants 2-Alphabetic Order and Transliteration Conventions for Devanagari		
UNIT	**TITLE**	**PERIODS**
2	**Grammar I**	**11**
Tenses-types of Tenses		
UNIT	**TITLE**	**PERIODS**
3	**Poetry and Translation**	**11**
ममम ममम - मममममम मम मम मम मममम ममम - मममम ममम ममम मममम - ममम ममम ममम ममममममम - मम मम मम ममम ममम - मम ममम ममम मम मम म मम - Translation of sentences to English.		
UNIT	**TITLE**	**PERIODS**
4	**Functional Hindi I**	**11**
Identify and use conjuncts in names and house objects - use of singular/plural, masculine/feminine		
UNIT	**TITLE**	**PERIODS**
5	**Language and Communication I**	**10**
Getting to know each other : recognize and write letters of names and places - identify basic sentence structure - recognize and memorize basic pharases when introduces oneself - greet each other and taking leave using appropriate cultural way - negate and affirm - ask questions with kyaa and kahaaN - use sentence structure SOV and Verb hona		
	TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	The students can identify the Hindi alphabet.
CO2:	The students can speak Hindi words and phrases.
CO3:	The students can recite simple poetry.
CO4:	The students can understand Tenses and are able to compare the Hindi structure with Tamil and English structure of sentences.
TEXT BOOKS:	
1	The Hindi Script and Sound System.
2	Anmol Kavitaen : Integral Publishers
REFERENCE BOOKS/RESOURCES:	
1	https://wp.nyu.edu/virtualhindi/house/
2	http://hindistartalk.lrc.columbia.edu/lesson/rathore-family-introduction/
3	http://hindistartalk.lrc.columbia.edu/lesson/rajawat-family-introduction/ (0.00 - 1.05)
4	http://www.learning-hindi.com/post/1156594856/lesson-51-possessive-pronouns-part-3-%E0%A4%95-kaa
5	http://www.learning-hindi.com/post/6324812777/lesson-115-%E0%A4%AD-bhee-too-also
6	http://hindistartalk.lrc.columbia.edu/lesson/rathore-family-our-home/
7	http://www.learning-hindi.com/post/880500641/lesson-19-numbers-11-20

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH09	**German I**	**0**	**0**	**2**	**0**	**2**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
Course Objective	
1	Students should become familiar with the German language; the 4 language skills are: listening, speaking, reading writing.
2	To empower the students to use German in daily communication.
3	To build up their confidence in the usage of German.
4	Familiarize the students with social, economic and cultural life in Germany.
5	To develop the written and communicative competence of the students.
6	The students should understand basics of grammar.

THEORY

UNIT	TITLE	PERIODS
1	**'Hello' and basics**	**9**

Language acts: greet and say goodbye/introduce oneself and others/talk about oneself and others/name numbers up to 20, telephone number and e-mail address/spell them/talk about countries and languages. **Vocabulary:** numbers from 1-20/countries and languages. **Grammar:** question/statement/verbs and personal pronouns. **Pronunciation:** alphabet. **Regional studies:** Countries and languages. **Film:** Good afternoon/The telephone number/I speak. **Deepening:** Advantages of learning German.

UNIT	TITLE	PERIODS
2	**'Friends, colleagues and me'**	**9**

Language acts: talk about hobbies/date/name days of the week/talk about work, professions and working hours/name numbers from 20 onwards/talk about seasons/create a profile on the internet. **Vocabulary:** hobbies/weekdays/numbers from 20/occupations/months and seasons. **Grammar:** articles/verbs and personal pronouns II/yes/no questions/plural of nouns/the verbs 'have' and 'be'. **Pronunciation:** sentence melody, questions and answers. **Regional studies:** Seasons and typical hobbies. **Film:** The trainee. **Deepening:** Principles of living together.

UNIT	TITLE	PERIODS
3	**'In the city'**	**9**

Language acts: Naming places and buildings/asking questions about places/assigning texts to a picture story/asking about things/naming means of transport/asking for directions and describing a route/understanding texts with international words/learning articles. **Vocabulary:** places and buildings/means of transport/directions. **Grammar:** definite, indefinite and negative article/imperative with 'Sie/you'. **Pronunciation:** long and short vowels. **Regional studies:** Sights, numbers, events in Hamburg. **Film:** Taxi ride/in the Hotel. **Motivation:** vision, goal setting.

UNIT	TITLE	PERIODS
4	**'Enjoy your meal'**	**9**

Language acts: talking about food/planning a purchase/conversing while shopping/conversing while eating/understanding texts with W-questions/ordering and leaning words. **Vocabulary:** meals/food/drinks/shops. **Grammar:** positions in a sentence/accusative/verb with accusative case. **Pronunciation:** Umlauts ä, ö, ü. **Regional studies:** Food in D-A-CH, professions related to food. **Film:** Breakfast/shopping. **Motivation:** plan progress

UNIT	TITLE	PERIODS
5	**'Day by day' & 'Time with friends'**	18
Language acts: understanding and telling the time/talking about the family/arranging an appointment/excusing oneself for being late/arranging an appointment by phone. **Vocabulary:** daily routine/time/family. **Grammar:** telling time with 'am, um, von…bis'/possessive article/modal verbs. **Pronunciation:** Hearing and speaking 'r'. **Regional studies:** Punctuality in D-A-CH. **Film:** You never have time! **Motivation:** Progress diary.		
Language acts: planning something together/talking about birthdays/understanding and writing an invitation/ordering and playing at a restaurant/talking about an event/finding specific information in texts/understanding event tips on the radio. **Vocabulary:** leisure activities/food/drinks/properties/events. **Grammar:** dates 'on..'/separable verbs/prepositions for + accusative/personal pronouns in accusative. **Pronunciation:** ei, eu, au. **Regional studies:** Pubs & Co. in D-A-CH. **Film:** Work? In the restaurant. Surprise! **Deepening:** Diversity of living together. Summarize course experiences. Write a short report.		
		54
COURSE OUTCOMES:		
Upon completion of this course, students will be able to:		
CO1:	Communicate in a simple way in German	
CO2:	Understand and use part of the basis of German grammar	
CO3:	Understand the social and cultural life in Germany in a rudimentary way, reflect on it comparatively also with others and exchange mails about it	
CO4:	Orientate themselves in the country and in the public sphere	
CO5:	Focus on own motivation and set goals	
CO6:	Communicate in German orally and in writing.	
CO7:	Refer to the dictionary for synonymous expressions and grammar.	
CO8:	Enlarge the vocabulary and understand the structure of sentences	
CO9:	To write a short report about their course experience and read it to each other	
TEXT BOOKS:		
1	Netzwerk, Deutsch als Fremdsprache A1.1, A1.2, Kursbuch plus Audio CD, workbook, Intensive trainer,Test booklet with audio CD, Klett Verlag	
2	Network of the course book with digital media (film, interactive blackboard pictures), teaching for online exercises, Facebook profile for country studies and communication	
3	Moodle	
REFERENCE BOOKS:		
1	Dictionary German-English, App	
2	Lingolia Deutsche Grammatik, App	
3	Deutsche Grammatik einfach erklärt, Easy Deutsch A1-B2 https://easy-deutsch.de/deutsche-grammatik-pdf/	
4	Woxikon, Online Synonym-Wörterbuch, https://synonyme.woxikon.de/	
5	Unterwegs Deutsch lernen, Deutschtrainer A1-App https://goethe.de/de/spr/ueb/dt1.html	

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC08	**BATTERY AND PHOTOVOLTAIC LAB**	**0**	**0**	**8**	**0**	**4**
PREREQUISITES:						
NIL / Course Code – Course Title / Topics						
LIST OF EXPERIMENTS:						
1. Identify specifications critical for battery-based inverters 2. Wire test and program battery based inverters 3. Discuss when and why breakers would be used rather than fuses 4. Use a 3-line diagram to wire a system 5. Discuss the order and perform safe installation practices of solar 6. Demonstrate the order of safe commissioning of solar panel 7. Demonstrate the order of shut-down and how to establish an electrically safe working environment						
TOTAL PERIODS :	**90**					

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVG04	**ELECTRICAL MACHINES LAB**	**0**	**0**	**6**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

LIST OF EXPERIMENTS:

AC MACHINES

1. Load test on single/three-phase transformer
2. O.C and S.C test on single/three-phase transformer
3. Parallel operation of single/three-phase transformer
4. Sumpner's test on single/three-phase transformer
5. Study of connections STAR/DELTA/ Scott connection on single/three-phase transformer

DC MACHINES

6. Load test on DC Motor (Shunt/series/Compound Motors)
7. Load test on DC Generators (Shunt/series/Compound Motors)
8. O.C.C of D.C Generators (shunt/separately)
9. Swimburne's /Hopkinson's test on DC Machines
10. Study on Retardation test and Speed control of DC Motors.
11. Field test of DC series Motor.

ELECTRONICS LAB DEVICE CHARACTERISTICS

1. Characteristics of Diodes (PN Junction / Zener diode).
2. Characteristics of a BJT (common base/Emitter/Collector)
3. Characteristics of a UJT/FET/IGBT.
4. Characteristics of an SCR/GTO/Triac
5. Characteristics of photon devices.

BIASING AND APPLICATIONS

6. Biasing Techniques for BJT(Fixed/collector to base/voltage divider biasing)
7. Biasing Techniques FET.
8. Rectifiers and Filters.
9. Diode clippers and clamping circuits.

TOTAL PERIODS :	**108**

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGPGSH10	**APPLIED CHEMISTRY**	**2**	**0**	**2**	**0**	**3**
PREREQUISITES:						
NIL / Course Code – Course Title / Topics						
Course Objective						
1.	To learn the fundamentals of Modern chemical lab, glassware,					
2.	To know about different types of Modern instruments used in chemical lab					
3.	To learn about various Solution preparation,					
4.	To learn the fundamentals of Green chemistry					
5.	To learn about modern chemistry systems					
THEORY						
UNIT	**TITLE**					**PERIODS**
1	**Introduction in basic chemistry**					**14**
Periodic table of elements-Chemistry in everyday life-Green technology & chemistry						
UNIT	**TITLE**					**PERIODS**
2	**Modern chemical lab & glassware**					**14**
Safety rules-Corrosive chemicals-Explosive chemicals-Chemicals storage-Waste chemicals disposal-Type of glassware-Storage & cleaning glassware-Wet chemical and dry chemicals. Lab practice and demonstration in analytical chemistry.						
UNIT	**TITLE**					**PERIODS**
3	**Modern instruments used in chemical lab**					**15**
Spectrophotometers (UV-vis, AAS, Infrared.)- Chromatography (TLC, Paper, GC-FID, MS)- Balances, Oven, Ventilation systems-pH, Turbidity meters, Conductivity meters. Lab Practice on Spectrophotometers, Chromatography.						
UNIT	**TITLE**					**PERIODS**
4	**Solution preparation**					**15**
Percentage, Molarity, Normality (Formula, definition, calculations)- Standard solutions-Glassware for preparation standard solutions-Chemical equation. Lab practice for solution preparation						
UNIT	**TITLE**					**PERIODS**
5	**Introduction to Green chemistry**					**14**
Early history- 12 Principles of green chemistry- Green chemistry & sustainable development- Sources of waste generation- Types of wastes- Waste as a resource- Greening energy sources- Implementation of Green Chemistry: Real world case studies Lab Practice on Bio-diesel production from algae real field study						
	TOTAL PERIODS:					**72**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to know:	
CO1:	Know the fundamentals of Modern chemical lab, glassware,
CO2:	Know about different types of Modern instruments used in chemical lab
CO3:	Understand about various Solution preparation,
CO4:	Understand fundamentals of Green chemistry
CO5:	Know about modern chemistry systems
TEXT BOOKS:	
1.	Green Chemistry for Beginners, edited by Rakesh K.Sgharma. 2021.
2.	Green Materials and Environmental Chemistry New Production; Technologies, Unique Properties, and Applications. Abu Zahrim Yaser. 2021.
REFERENCE BOOKS:	
1.	Laboratory Manual for Principles of General Chemistry. Jo Allan Beran. 2013

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGPGSH11	**APPLIED PHYSICS – II Laboratory**	**0**	**0**	**6**	**0**	**3**

PREREQUISITES:		
NIL / Course Code – Course Title / Topics		
Course Objective		
1.	To understand the basic crystal structures and diffraction types of bondings.	
2.	To understand the knowledge of electrical motors	
3.	To understand the fundamental principles of semiconductors	
4.	To study the basic principle and properties of laser	
5.	Gives the Knowledge of Conventional and non-conventional energy sources	
	TITLE	**PERIODS**
	Applied Physics II Laboratory	**108**

Experiments

1. Seven types of crystalline solids (3d model by atomic model set or software)
2. PN- Junction Diode (IV)
3. Zener Diode Characteristics as Voltage Regulator
4. Voltage Regulation using IC7812
5. Laser Particle Size analyser
6. Compound Pendulum
7. Potentiometer
8. Photovoltaic systems
9. BLDC Motor Controller

TOTAL PERIODS:	**108**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to know:	
CO1:	Crystal structures and different unit cells
CO2:	Electrical motors
CO3:	The fundamental principles of semiconductors
CO4:	Principle of laser and its properties
CO5:	Conventional and non-conventional energy sources

TEXT BOOKS:	
1.	Kittel, (2003), Introduction to Solid State Physics, Willey Eastern Ltd.
2.	Brij Lal and N Subrahmanyam (2016), Heat Thermodynamics S Chand & CompanyPvt Ltd, New Delhi.
3.	Pillai, S.O. (2002), Solid State Physics New Age International (P) Ltd.

4.	Murugeshan R. and KiruthigaSivaprasath (2016) Modern Physics, S. Chand &CO.Ltd, New Delhi,
5.	Theraja, B.L. (2016), Modern Physics, S. Chand & CO Ltd, New Delhi
REFERENCE BOOKS:	
1.	Raghavan, V. (2004), Materials Science and Engineering, Prentice Hall of India PrivateLimited, New Delhi
2.	Rajaram J B (1990), Heat and thermodynamics, S Chand & Co., New Delhi.
3.	Lasers Fundamentals and Applications, K. Thyagarajan, AjoyGhatak, Springer Science & BusinessMedia, 2010
4.	Kalogirou S.A., 2013, Solar Energy Engineering: Processes and Systems, 2nd Edition, Academic Press.
5.	Zobaa A. F and Ramesh Bansal, 2011, Handbook of Renewable Energy Technology, World Scientific

	Course Title	Periods per week				
	Integral Yoga & Values-based Life and	L	T	P	R	Credits
BVGPGSH12	**Leadership for Human Unity- II**	**1**	**0**	4	0	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1	To understand and develop a consciousness-centered worldview
2	To demonstrate the major conception of Integral Yoga and the triple movements
3	To learn Radical Transformational Leadership tools to apply what I stand for (care about) in my everyday practice.
4	To learn systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment.
5	To learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

THEORY

UNIT	TITLE	PERIODS
1	**Consciousness-centered worldview**	**6**

Consciousness-meaning & concepts; Broad regions of Consciousness; Evolution & Involution.

UNIT	TITLE	PERIODS
2	**Integral Yoga: An Adventure of Consciousness**	**6**

Integrality; Physical, vital and mental consciousness; The psychic being; Mental evolution; Liberation and Transformation

UNIT	TITLE	PERIODS
3	**The Triple Movements**	**6**

Aspiration, Rejection and Surrender

LABORATORY **72**

(i) Integrity (being whole and undiminished)
(ii) Reviewing my BTI- CSFR and Respond & Realize
(iii) Judgment & Discernment
(iv) Synergistic Operational Strategies - Part 1(understanding)
(v) Synergistic Operational Strategies - Part 1 - Reviewing my BTI
(vi) Guilt the hidden payoff
(vii) Three domains of my Listening and speaking
(viii) Synergistic Operational Strategies - Part 2
(ix) Likert Emberling – Stages of leadership
(x) Overload and Overwhelm
(xi) Conversations for action - committed requests, committed responses.
(xii) Principled Outrage distinguished from Destructive Anger
(xiii) Transformational Results Chain (understanding)
(xiv) Transformational Results Chain and My project: Individual work

TOTAL PERIODS: 90

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

CO1:	understand and develop a consciousness-centered worldview
CO2:	explain the major conception of Integral Yoga and the triple movements
CO3:	practice Radical Transformational Leadership tools to apply what I stand for (care about) in my everyday life.
CO4:	apply systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment.

CO5:	have granularity to choose to transcend emotions and fears and work out of their full potential
REFERENCE COURSES/BOOKS:	
1	https://www.ipi.org.in/infinity/infinityfiles/0-2-2-integrality.php
2	Sri Aurobindo. Life Divine & Synthesis of Yoga.
4	Monica Sharma. (2017). Radical Transformational Leadership: Strategic Action for Change, North Atlantic Publishing, at Berkeley, California

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC09	**ENERGY AUDIT AND MANAGEMENT**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn Energy Auditing Techniques , Operation and maintenance of energy audit
2.	To learn Insulation and Refractories
3.	To learn Steam system, Cogeneration, Cooling tower and Waste heat recovery
4.	To learn Energy Conservation (Electrical Systems)

THEORY

UNIT	TITLE	PERIODS
1	**Energy Auditing Techniques**	**14**

Energy Audit: Definition, need and objectives, types of Energy Audit, Energy audit strategies, Basic Components of Energy Audit, Energy Audit Instruments, Important survey items: Methodologies of conducting energy audit: Post audit analysis:

UNIT	TITLE	PERIODS
2	**Operation and maintenance of energy audit**	**15**

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments, Economic benefit analysis.

UNIT	TITLE	PERIODS
3	**Insulation and Refractories**	**14**

Insulation type and application, economic thickness of insulation, heat savings and application criteria, refractory-types, selection and application of refractories, case studies.

UNIT	TITLE	PERIODS
4	**Steam system, Cogeneration, Cooling tower and Waste heat recovery**	**15**

Steam system

Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery systems, identifying opportunity for energy saving, case studies

Cogeneration

Need, applications, advantages, topping cycles, bottoming cycles, combined cycles, steam tracking mode, electricity tracking mode, saving potential, case studies.

Cooling Tower

Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, case studies

Waste heat recovery

Availability and reversibility, first and second law efficiency, classification, advantages and applications, commercially viable heat recovery devices, saving potential, case studies

HVAC and refrigeration system, vapor compression refrigeration cycle, refrigerants, factors affecting refrigeration and air conditioning system performance and savings potential. Vapor absorption refrigeration system, working principle, types and comparison with vapor compression system, saving potential, distribution system for conditioned air.

UNIT	TITLE	PERIODS
5	**Energy Conservation (Electrical Systems)**	**14**
Electrical systems and bill analysis: Electricity billing, electrical load management, maximum demand control, Energy conservation opportunities in Lighting systems, Electric motors, Compressed air systems, HVAC & refrigeration system, Fans & blowers, Pumps, Cooling tower and DG system, case studies.		
	TOTAL PERIODS:	**72**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to know:	
CO1:	Energy Auditing Techniques , Operation and maintenance of energy audit
CO2:	Insulation and Refractories
CO3:	Steam system, Cogeneration, Cooling tower and Waste heat recovery
CO4:	Energy Conservation (Electrical Systems)
TEXT BOOKS:	
1.	Industrial energy management and utilization, Larry Witte, CRC Press, First edition, 1987
2.	Energy Management Principles, applications, benefit and saving, Craig B. Smith, Kelly E. Parmenter, Pergamon, First edition, 2013.
REFERENCE BOOKS:	
1.	Energy Conservation Manual, Wulfingh off, Donald, Energy Institute Press,First edition, 1999.
2.	Industrial Energy Conservation, Reay D.A, Pergamon Press, First edition, 1977.
3.	Energy Efficiency for Engineers and Technologists, T.D. Eastop, D.R. Croft, Logman Scientific &Technical. First edition, 1990

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGPGSH13	**INDUSTRIAL MANAGEMENT AND PROFESSIONAL ETHICS**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	To understand the management process in industry
2	To understand the difference between between private and public sectors.
3	To know laws in industrial area
4	To enable the students to create an awareness on Engineering Ethics and Human Values.
5	To instill Moral and Social Values and Loyalty and to appreciate the rights of others.

THEORY

UNIT	TITLE	PERIODS
1	**INTRODUCTION ABOUT MANAGEMENT**	**14**

Growth of industry - The management of men, materials and machines, the art of management, Sources of capital- industrial individual enterprise, private partnership and private Ltd. Co., Joint Stock Co. shares, debentures, financial agencies and their role in promoting industries. Break even analysis.

UNIT	TITLE	PERIODS
2	**PRIVATE SECTOR AND PUBLIC SECTOR**	**14**

Public sector enterprise - merits and demerits of public sector industry and private sector industry, Line, staff and functional organizations, reasons for the choice of various types of organization, functions of different departments (stores, purchase and sales), departments relationship between individual departments.

UNIT	TITLE	PERIODS
3	**ENGINEERING ETHICS**	**14**

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT	TITLE	PERIODS
4	**LABOUR, INDUSTRIAL & TAX LAWS**	**15**

Evolution of industrial law, factory act, workmen compensation act, payment of wages act, employee's state insurance act, Industrial dispute act. Role of technician in industry: Position of technician in various engineering departments, Role of a supervisor in industry, Foremanship, duties and qualities of a good foreman.

UNIT	TITLE	PERIODS
5	**HUMAN VALUES**	**15**
Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.		
	TOTAL PERIODS:	**72**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to:		
CO1:	understand the management process in industry	
CO2:	understand the difference between private and public sectors.	
CO3:	know laws the industrial area	
CO4:	create an awareness on Engineering Ethics and Human Values.	
CO5:	Discuss the ethical issues related to engineering and realizing the responsibilities and rights in the society	
TEXT BOOKS:		
1	Khanna, O.P. - Industrial Engineering and Management, Khanna Publishers, New Delhi.	
2	Martand Telsang - Industrial and Business Management, S.Chand & Co., 2001	
REFERENCE BOOKS:		
1	Jain, K.C. and Agarwal, L. N. – Production Planning Control & Industrial Management, Khanna Publishers, New Delhi.	
2	Banga, Sharma & Agrawal, Industrial Engineering & Management Khanna Publishing	

Course Code	Course Title	Periods per week				Credits
BVGPGSH14	**HINDI II**	**L**	**T**	**P**	**R**	
		3	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	To introduce the students to Hindi Alphabet and To encourage the students to speak Hindi
2	To enable students to use Hindi in day-to-day communication
3	To build up their confidence in the usage of Hindi
4	To expose them to light prose
5	To introduce them to the basics of Grammar

THEORY

UNIT	TITLE	PERIODS
1	**Sentences and Translation**	**11**

Hindi Phrases and Sentences (Indentifying and Writing) -Sentences Translation from English.

UNIT	TITLE	PERIODS
2	**Grammar II**	**11**

Tenses - Adjectives - Singular/ Plural - Nouns and Genders

UNIT	TITLE	PERIODS
3	**Prose**	**11**

Simple Proses from the preacribed prose book -(1 to 5 prose)

UNIT	TITLE	PERIODS
4	**Functional Hindi I**	**11**

Communication (About Daily Routines, Various Daily Activities, Time, Name of the days in a week) - Use of Noun adjective agreements, feminine and masculine - Use personal pronouns in direct and oblique forms - Use of present habitual - Use of reflexive Pronouns (apnaa, khud) - Use of Numbers (1-80) - Learning about what their peers and their heroes do everyday - Communication on roommate routine and Preferences.

UNIT	TITLE	PERIODS
5	**Language and Communication II**	**10**

Where am I From? :about where people are from - personal information - name and identify relatives - express possession with kinship terms (kaa/ke/kii) - about age - use interrogative pronouns (kaun, kiskaa, kiskii, kiske, kahaaN se) - use possessive pronouns - use past habitual tense - use of numbers (1-70) - use emphatic hii and bhii

TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	The students can identify the Hindi alphabet and make phrases and sentences.
CO2:	The students can speak and understand simple phrases and sentences of day to day conversation in Hindi.
CO3:	The students can read stories written in simple Hindi.
CO4:	The students can familiar with the basics of grammer- senctence construction, Sanghya, Saravanaam, Visheshan, Kriya, Sambandhbodhak, etc.,
TEXT BOOKS:	
1	The Hindi Script and Sound System.
REFERENCE BOOKS:	
1	https://learningmole.com/hindi-alphabet-letters-pronunciation-guide/
2	http://www.learning-hindi.com/post/853847321/lesson-15-pronouns
3	http://www.learning-hindi.com/post/1222427011/lesson-57-what-time-is-it
4	http://www.learning-hindi.com/post/1162464592/lesson-52-possessive-pronouns-part-4-%E0%A4%85%E0%A4%AA%E0%A4%A8-apnaa
5	http://hindistartalk.lrc.columbia.edu/lesson/rajawat-family-introduction/ (0.00 -1.05)
6	http://www.learning-hindi.com/post/1156594856/lesson-51-possessive-pronouns-part-3-%E0%A4%95-kaa
7	http://www.learning-hindi.com/post/880500641/lesson-19-numbers-11-20
8	http://www.learning-hindi.com/post/6324812777/lesson-115-%E0%A4%AD-bhee-too-also
9	http://hindistartalk.lrc.columbia.edu/lesson/rathore-family-our-home/
10	http://hindistartalk.lrc.columbia.edu/lesson/rathore-family-introduction/

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH14	**German II**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1	The course aims to achieve competence according to the scales of the Common European Framework of Reference for Languages, in the four linguistic skills – speaking, listening, reading, and writing. The students will be dealt with in an everyday and balanced way, and grammatical phenomena will be analysed and explained.
2	The course content aims at understanding and possible participation in social, economic, and cultural life in Germany and helps students to assess living situations in Germany and to find their way in everyday, professional and university areas as well as with the authorities.
3	To build students confidence through various methods such as democratic teaching style,inclusion of the students' world of life and experience, progress diary, information and protocol techniques, mind mapping, think-pair-share, communication, discussion and facilitation techniques, etc.
4	The teaching of values and orientation knowledge is a special aspect of this German course 2. The aim is to discover cultural differences and similarities. Values such as respect, tolerance, helpfulness, responsibility, reliability, honesty, politeness, and a sense of order will be focused on.
5	Another focus will be 'Motivation to learn', i.e., students will learn to set goals, track their progress, and learn deal with setbacks.
6	Project work and business games play an important role in preparing students for their future professional tasks. In this way, theycan use their existing linguistic, methodological, and professional knowledge even at this language level to realize a project, plan it, search for it,carry it out and present it. This gives room for self-directed, creative, experimental workand learning in the group.

THEORY

UNIT	TITLE	PERIODS
1	**Communication: Coversation on phone & official letters , Communication: Searching for an apartment to rent and Communication at work place**	**11**

Language actions: Making appointments/understanding and giving instructions/Understanding and answering letters/talking about language learning/finding information in texts/recognizing situations in conversation/understanding conversations. Vocabulary: everyday office life/telephone/letter standards/language learning. Grammar: prepositions with dative/articles in dative/possessive Articles: Accusative. Pronunciation: Long and short 'e'.Regional studies: Social networks in D-A-CH. Film: In the company/How does it work? Motivation: Make a promise to yourself. **Language activities**: Understand flat advertisements/describe a flat/plan the flat furnishing/answer an invitation in writing/talk about a flat furnishing/express liking and disliking/talk about forms of housing/write a text about a flat. Vocabulary: flat/rooms/furniture and devices/colours/housing styles. Grammar: Adjective with 'to be' (+very/to) #in' with accusative/adjective prepositions with dative case. Pronunciation: s and sh. Regional studies: Types of housing in D-A-CH. Film: My flat/How to find a flat? Knowledge of values and orientation: 'Living

and neighbourhood', living together and house rules, quiet times, night's rest, politeness. . **Language acts:** describing a daily routine/talking about the past/understanding job advertisements/expressing opinions about jobs, understanding blogs about jobs/preparing a telephone conversation, making phone calls, and asking questions/talking about jobs.Vocabulary: professions and places of work/study/jobs. Grammar: Perfect/Participle II: combining regular and irregular verbs/sentences: 'and, or, but'. Pronunciation: listening to and speaking h. Regional studies: Seasonal jobs in D-A-CH. Film: Felix's day/student jobs. Knowledge of values and orientation: 'World of wok and economy', working and paying taxes, compulsory insurance pensions-health insurance-unemployment benefit, dealing with money.

UNIT	TITLE	PERIODS
2	**Shopping&health: Clothes and fashion and Shopping & health: Healthy and lively**	11

Language acts: talking about clothes/understand a chat about a purchase/talking about the past/have conversations when shopping for clothes/finding your way around the department stores/understand and research information about Berlin. Vocabulary: clothes/floors and goods in a department store/shops and stores. Grammar. 'Which one? Which? This one; that one; these'/participle II: separable and non-separable verbs/personal pronouns in the dative case. Pronunciation: stressing verbs with prefixes. Regional studies: Trendy city Berlin. Film: Can I h help you? I'll try it on!Motivation: Prepare for possible setbacks. **Language acts:** giving personal details/naming body parts/understanding and explaining a sports exercise/reproducing requests/conducting conversations at the doctor's office/understanding and giving instructions/understanding and giving health tips/inferring words. Vocabulary: body parts/body care/illnesses/medications/jobs. Grammar: imperative/demand sentences/'should, must, must not, may'. Pronunciation: p and b, t and d, k and g. Regional studies: Home remedies for illnesses. Film: Washing hair/The accident. Knowledge of values and orientation: 'Health', health care system, solidarity principle, family doctor comes before hospital, emergency, precaution, prevention.

UNIT	TITLE	PERIODS
3	**Travelling and going out: on vacation! , Travelling going out: booking at Restaurant**	11

Language actions: Understand suggestions for a city tour/describe a route/write a postcard/describe the weather/understand travel reports/describe problems in the hotel/complain in the hotel/talk about travel destinations. Vocabulary: types of holidays and destinations/sightseeing/weather. Grammar: Pronouns: 'man'/Questions words: 'Who? Whom? What?' Adverbs of time: 'first, then, later, at the end'. Pronunciation: f/v/w. Regional studies: Popular travel destinations in Germany. Film: Packing your suitcase/How was it? Motivation: Celebrate the positive and thank helpers. **Introducing** yourself/reporting about the past/getting an appointment/understanding information on a homepage/booking a restaurant. Vocabulary: leisure, activities, in a restaurant. Grammar: Genitive: name + s/repetition: perfect/subordinate clause with 'because'.Pronunciation: 'ch'. Strategy: Learning words with all senses. Regional studies: Eating without light. Network-flat share community: That's us. We brought something with us.

UNIT	TITLE	PERIODS
4	**Social: After school time , Social: Expressing feelings and Social: Living in the city**	11

Understanding reports from school days/talking about school days/writing comments/understanding a radio programme, talking about experiences7speaking one's own mind/presenting something.Vocabulary: school experiences, school subjects, types of school. Grammar: modal verbs in the past tense, repetition: articles/possessive articles in the dative case Pronunciation:'e'. Strategy: learning important phrases by heart. Regional studies: Types of school in Germany. Network-flat-sharing community: The school project. Knowledge of values and orientation: Friendships **Talking** about feelings/expressing congratulations/expressing thanks/expressing joy or regret/talking about an event7understanding and writing blogs. Vocabulary: celebrations, events, feelings, congratulations, thanks. Grammar: subordinate clause with 'if', reflexive verbs. Pronunciation: emotional speech. Strategy. Structuring texts. Regional studies. A festival in the north. I feel at home here. Network-flat-sharing community: Bad mood/Everything will be fine! The message. Knowledge of values and orientation: Stress and mental

health. **Understanding** a job interview/asking for things/understanding conversations at banks and authorities/asking politely for something/following a city tour/describing a city Vocabulary: city, job interview, bank, authority. Grammar: adjectives after the definite article/prepositions 'without' + accusative and 'with' dative/subjunctive II: 'could'. Pronunciation:friendly requests. Strategy: imagining a situation. Regional studies: around the ring: Vienna. Network-flat-sharing community: A job for Max/The trial job. Motivation: thanking yourself, sharing it with others.		
UNIT	**TITLE**	**PERIODS**
5	**Working worlds: Always online?, Working worlds: Career**	**10**
Talking about advantages and disadvantages/formulating comparisons/doing an interview. Understanding opinions in texts/expressing one's own opinion/talking about films/understanding film descriptions/describing a film/understanding and writing comments on a film.Vocabulary: media, activities with media, film. Grammar: Adjectives. Comparative and superlative, comparisons with 'as' and 'how' subordinate clause with 'that'.Pronunciation: 'b' or 'w'. Strategy: reading long texts. Regional studies: Cinema! Cinema!Network-flat-sharing community: Do you have time? Wait a minute! Picnic in the park. Knowledge of values and orientation:Advantages and disadvantages of the internet. **Conducting** a conversation at the ticket counter/Telling information from texts/Expressing career wishes/Writing about a dream job/Preparing a telephone conversation/Transmitting information from a text. Vocabulary: activities at work, travelling by train, on the phone. Grammar: adjectives after the indefinite article/'to become'. Pronunciation: 'm' or 'n'. Strategy: Talking on the phone in German. Regional studies: The modern world of work. Network-flat-sharing community: When are we going? The taster course. Knowledge of values and orientation: Extension: 'Working world and economy'		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to:		
CO1:	Understand the basics of German grammar.	
CO2:	Have increased vocabulary knowledge.	
CO3:	Focus on their own motivation, set goals and check them, follow them up (progress diary) and deal with possible setbacks.	
CO4:	To understand the social, cultural and economic life in Germany and to be able to reflect with others on the respective values in a comparative way.	
CO5:	Read, listen and understand better.	
CO6:	Communicate orally and in writing in German.	
CO7:	Be able to refer to a dictionary, synonym dictionary and use language apps/websites.	
CO8:	To be able to realise a small project, plan it, look for it, carry it out and present it.	
CO9	To be more self-confident.	
TEXT BOOKS:		
1	Netzwerk neu, Deutsch als Fremdsprache, A1, A2, Klett Verlag Kursbuch plus audios and videos Workbook plus audio CD Intensive trainer Test booklet with audio CD	
2	Audio files for download, Klett-Augmented-App	
3	Facebook profile for country studies and communication https://www.facebook.com/goetheinstitut.deutsch	
4	YouTube, 24 Stunden Deutsch/Goethe Institut:https://www.youtube.com/24hdeutsch	
5	Goethe Institute, Online-Spiele& Quiz, https://www.goethe.de/de/spr/ueb.html	

REFERENCE BOOKS:	
1	Dictionary German-English, App
2	Lingolia Deutsche Grammatik, App
3	Deutsche Grammatik einfach erklärt, Easy Deutsch A1-B2 https://easy-deutsch.de/deutsche-grammatik-pdf/
4	Woxikon, Online Synonym-Wörterbuch https://synonyme.woxikon.de
5	Unterwegs Deutsch lernen, Deutschtrainer A2-App
6	Es ist nie zu spät, erfolgreich zu sein, Ben Furman, TapaniAhola, Carl-Auer-Verlag
7	Dowling,Dave Oxford Guide To Effective Writing And Speaking

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC10	**ENERGY AUDIT LAB**	**0**	**0**	**8**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

LIST OF EXPERIMENTS:

1. Computing efficiency of dc motor and induction motor
2. Calculating the efficiency of boiler/ blowers / compressors.
3. Draw the energy flow diagram for the industry/shop floor division
4. Industry visit with an aim of
   1. Studying various energy management system prevailing in a particular organization/ industry
   2. Identify the various energy conservation methods useful in a particular industry
5. Study of various instrument used for energy audit: lux meter, power analyze, flue gas analyzer.
6. Identify the energy conservation opportunities in a lab, department or institute.
7. Prepare a sample energy audit questionnaire
8. Prepare a sample energy audit report.
9. Prepare a technical report on energy conservation act 2003.
   Studying the various energy conservation methods useful in power generation, transmission and distribution.

TOTAL PERIODS :	**144**

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH16	**Integral Yoga & Values-based Life and Leadership for Human Unity- II Refresher and Application**	**1**	**0**	**4**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
COURSE OBJECTIVES:	
1	To incorporate aspects of integral yoga into life with meditation and reflection
2	To incorporate aspects of integral yoga into life with suryanamaskar
3	To integrate Radical Transformational Leadership tools in everyday practice.
4	To design projects for system and cultural shift from universal values
5	To learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

THEORY		
UNIT	**TITLE**	**PERIODS**
1	**Review of the triple movement**	**9**
Aspiration, Rejection and Surrender		
UNIT	**TITLE**	**PERIODS**
2	**RTL (Radical Transformational Leadership) Book Reading**	**9**
Understanding the praxis around the world around RTL		
LABORATORY		
UNIT	**TITLE**	**PERIODS**
1	**Meditation**	**14**
To learn and incorporate daily meditation		
UNIT	**TITLE**	**PERIODS**
2	**Suryanamaskar**	**14**
To learn and incorporate suryanamaskar		
UNIT	**TITLE**	**PERIODS**
3	**Reflection**	**10**
To reflect weekly on the progress made physically and mentally		
UNIT	**TITLE**	**PERIODS**
4	**Refresher and triad practice**	**18**
Reflection on the tools applied in day to day life. Conversations for clarity and refreshers.		

UNIT	TITLE	PERIODS
5	**Design and implementation of breakthrough initiative**	**16**
Refresher on design templates and design and refining the breakthrough initiative at college.		
	TOTAL PERIODS	**90**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to:		
1	Develop in meditation and reflection	
2	Develop physically through suryanamaskar	
3	Use Radical Transformational Leadership tools in everyday practice.	
4	Design projects for system and cultural shift from universal values	
5	Notice distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential	
REFERENCE COURSES/BOOKS:		
1	Altered Traits: Science Reveals How Meditation Changes Your Mind, Brain, and Body- Daniel Goleman and Richard Davidson	
2	Monica Sharma. (2017). Radical Transformational Leadership: Strategic Action for Change, North Atlantic Publishing, at Berkeley, California	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC11	SOLAR THERMAL TECHNOLOGY	4	0	0	0	4

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn the fundamentals of Solar Radiation Geometry
2.	To know about Solar Collectors, Thermal Analysis
3.	To learn the fundamentals of Solar Thermal Energy Storage
4.	To learn Solar thermal energy systems, Economic analysis for solar thermal engineering projects
5.	To know the various application of solar systems

THEORY

UNIT	TITLE	PERIODS
1	**Solar Radiation Geometry**	14

Solar angles; the earth and solar constant; day length; angle of incidence on tilted surface; variation of extra terrestrial radiation ;solar radiation at the earth's surface; solar radiation data; sunrise, sunset and day length; local apparent time; instruments for measuring solar radiation and sunshine; solar radiation on tilted surfaces; analysis of Indian solar radiation data and applications

UNIT	TITLE	PERIODS
2	**Solar Collectors: Thermal Analysis**	14

Flat plate collectors: Effective energy losses; thermal analysis; heat capacity effect; overall loss coefficient; collector efficiency factor; collector heat removal factor; efficiency off lat plate collectors; testing methods. Evacuated tube collectors: Types; thermal analysis; testing methods. Concentrating collectors: Designing and types; acceptance angle; geometric concentration ratio; optical efficiency; thermal efficiency; testing methods. Selective surfaces

UNIT	TITLE	PERIODS
3	**Solar Thermal Energy Storage**	15

Low, Medium and High temperature thermal energy storage. Sensible heat storage: Types of sensible heat storage; energy analysis in a liquids tratified tank; design aspects; materials for latent heat storage.

Latent heat storage: Phase change material(PCM) for latent heat storage; inorganic and organic PCM's; calculation of quantity of material required for latent heat thermal energy storage; design of a solar thermal device with the provision of thermal storage. Thermo-chemical storage: Materials; merits and demerits of thermo-chemical storage; potential of thermo-chemical storage materials for high temperature applications

UNIT	TITLE	PERIODS
4	**Solar thermal energy systems**	15

Solar water heating systems: Materials and components; Natural flow; Forced flow; applications Solar air heating systems: Description and classifications; porous and non-porous type; testing of solar air heater, applications. Solar concentrating systems: Materials for concentrators; types of concentrators, single axis and two axis tracking. Solar drying: Working principle; open sun drying; direct solar drying; indirect solar drying; Designing of solar drier;

psycho metric chart; energy balance equation. Solar distillation: Working principle; thermal efficiency; various designs of solar still. Solar pond: Description; Non – convective solar pond; operational problems; other solar ponds. Solar cookers: Types of solar cookers; first figure of merit and second figure of merit. Solar energy for industrial process heat: Hot water, hot air and steam based industrial process heat systems; Solar refrigeration and air conditioning: Principle of absorption cooling; basics of absorption cooling; lithium bromide-water absorption system; vapor compression refrigeration Solar thermal power generation: Principles of solar engines; solar thermal power plants: parabolic through, central receiver, parabolic dish, compact Fresnel linear reflector technology.		
UNIT	**TITLE**	**PERIODS**
5	**Economic analysis for solar thermal engineering projects**	**14**
Annualized cost method: annualized cost; annualized capital cost; salvage value; capital recovery factor; salvage fund factor; annualized maintenance cost; Life cycle savings: savings per day; present worth of annual savings; present worth of cumulative savings. Payback period		
	TOTAL PERIODS:	**72**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	To know about Solar Radiation Geometry	
CO2:	The working of Solar Collectors, Thermal Analysis	
CO3:	About principles of Thermal Energy Storage	
CO4:	To learn about Solar thermal energy systems	
CO5:	To calculate the Economic analysis for solar thermal engineering projects	
TEXT BOOKS:		
1.	Solar Thermal Engineering Process, Duffle and Beckman, John Wiley & Sons, Fourth edition, 2013	
2.	Solar Energy, J.S. Hsieh, Prentice Hall Inc, first edition, 1986.	
REFERENCE BOOKS:		
1.	Applied Solar Energy, A.B. Meinel and M.B. Meinel,Addison – Wiley, Second edition, 1977	
2.	Solar Energy: Fundamentals & Applications, GargHP., Prakash J, Tata Mc Graw Hill, First edition, 1997	
3.	Solar Energy, S.P. Sukhatme, Tata McGraw-Hill, Third edition, 2008	

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC12	**BIOENERGY TECHNOLOGY**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn the basic of Biomass Resources
2.	To learn the different Processing of Biomass
3.	To learn about Biochemical Conversions
4.	To learn and do the practical in Algae for Biofuel application
5.	To understand the basic concepts of bioenergy and its technologies

THEORY

UNIT	TITLE	PERIODS
1	**Biomass Resources**	**14**

Biomass Resources: Agricultural produce and waste biomass, Biomass from forest produce and energy plantation. Biomass yield, availability, energy potential. Industrial biomass, Biomass from urban and municipal wastes

UNIT	TITLE	PERIODS
2	**Processing of Biomass**	**15**

Physical properties of biomass: Moisture, bulk density, size, grind ability, crushability. Chemical composition of biomass- estimation of volatile matter, cellulose and lignin content. Properties of municipal solid waste – MSW management principle – Segregation of waste biomass – refuse derived fuels. Pelleting and briquetting of solid biomass – Process flow – factors influencing heat values. Pretreatment of biomass for energy enhancement – Torrefaction

Thermo chemical Conversions

Thermal Conversion: Direct combustion, incineration, pyrolysis, gasification and liquefaction; economics of thermo chemical conversion. Biogasification:

Chemical Conversion: Hydrolysis & hydrogenation; solvent extraction of hydrocarbons; solvolysis of wood, biocrude, biodiesel production via chemical process; catalytic distillation; transesterification methods.

UNIT	TITLE	PERIODS
3	**Biochemical Conversions**	**14**

Fermentation and biochemical processes– Chemical kinetics – Bioreactors for ethanol production. Biomethanation process –anaerobic digestion for biogasification. Biogas digester types, biogas utilization. Biodiesel production – various biomass feedstock for biodiesel.

UNIT	TITLE	PERIODS
4	**Algae for Biofuel application**	**15**

Introduction to algal biomass; large scale culture and harvest methodologies-Open Raceway ponds & photo bioreactors; biodiesel standards and blending of biofuels.

UNIT	TITLE	PERIODS
5	**Biofuels Standards &Power Generation**	14
Adaptation of biofuel in power generation and transport; Biofuel economy; Biofuel road map of India; Entrepreneurship in biofuels; Case studies		
	TOTAL PERIODS:	72
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	the basic of Biomass Resources and its applications	
CO2:	the different Processing of Biomass	
CO3:	about Biochemical Conversions	
CO4:	the practical applications in Algae for Biofuel application	
CO5:	And understand the basic concepts of bioenergy and its technologies	
TEXT BOOKS:		
1.	Lehninger's Principles of BiochemistrybyDavidL.NelsonandMichaelM.Cox,MacmillanWorthpublisher,2009	
2.	Biochemistry6thedition byJeremyMBerg,LubertStryer,JohnL.Tymoczko, 2008.	
REFERENCE BOOKS:		
1.	Biochemistry,5thEdbyEricE Conn,PaulK Stumpf,GeorgeBrueningandRoyHDoi,2009	
2.	DictionaryofRenewableResources-2ndEdition,Revisedand Enlarged,Zoebelein,Hans,Wiley-VCH,2001	
3.	RenewableEnergy,ThirdEdition,BentSorensen,AcademicPressAugust2004	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVG05	MATERIAL SCIENCE AND MATERIALS	3	0	0	0	3

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn structure of metals and their deformation
2.	To learn various ferrous metals
3.	To know about heat treatment
4.	To learn various non-ferrous metals
5.	To know the different testing of metal

THEORY

UNIT	TITLE	PERIODS
1	STRUCTURE OF METALS AND THEIR DEFORMATION	10

Crystal structures (BCC, FCC and HCP systems), atomic packing factor, density, Crystalline perfections; point defects, line defects- edge and screw dislocations, surface defects, volume defects. Mechanism of Elastic & plastic deformation (slip and twinning), slip, work hardening theory - Deformation of metals, effects of cold and hot working operations over them. Recovery re-crystallization and grain growth, solid solutions, alloys and inter metallic compounds - Importance and Objective of Phase Diagram Systems, Phase and Structure Constituents, Cooling Curves, Unary & Binary Phase Diagrams, Gibbs's Phase Rule, Lever Rule, Eutectic, and Eutectoid Systems, Peritectic and Peritectoid Systems. Iron Carbon Equilibrium Diagram and TTT

UNIT	TITLE	PERIODS
2	FERROUS METALS	11

Classification of iron and steel - Cast iron types as per I.S. - White, malleable, Grey. Steels: Classification of steels according to carbon content and according to use as per I.S. - Mechanical properties of various steels and their uses. Availability of steel in market, Its forms and specifications. Alloy Steel: Effect of alloying various elements, viz Cr, Hi, Co, V,W, Mo, Si, and Mn, on mechanical properties of steel, Common alloy steels, viz, Ni-steel, Ni-Cr-steel, Tungsten steel, Cobalt steel, Stainless Steel, Tool steel - High Carbon Steel, High Speed steel, Tungsten Carbide, Silicon manganese steel, Spring Steel, Heat Resisting alloy Steels etc.

UNIT	TITLE	PERIODS
3	HEAT TREATMENT	11

HEAT TREATMENT OF STEELS: Annealing, Normalising, Hardening & Tempering, quenching media, other treatments such as Martempering, Austempering, Ausforming. temper embrittlement, quench cracks, Hardenability& hardenability testing, Defects due to heat treatment and remedial measures.

Classification of surface hardening treatments, Carburising, heat treatment after Carburizing, Nitriding, Carbo-nitriding, Flame hardening, and Induction hardening

UNIT	TITLE	PERIODS
4	**NON-FERROUS METALS**	**11**
NON-FERROUS METALS AND ALLOYS: Copper, Aluminium, Nickel, Zinc and Lead based alloys. Heat treatment of Nonferrous metals: Precipitation/ Age Hardening, solid solution strengthening, dispersion strengthening. Foundry of non-ferrous metals such as Aluminum		
UNIT	**TITLE**	**PERIODS**
5	**TESTING OF METAL**	**11**
Study of destructive testing: Tensile test, Engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, different hardness tests - Vickers, Rockwell, Brinell, Micro Hardness Test, Impact test, fatigue test, creep test		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	The structure of metals and their deformation	
CO2:	The various ferrous metals	
CO3:	about heat treatment and its methods	
CO4:	various non-ferrous metals and its properties	
CO5:	the different testing of metal	
TEXT BOOKS:		
1.	H.Avner, Introduction to Physical Metallurgy, Tata-McGraw Hill Publishing Co., New Delhi, 2nd Ed., 26th Reprint, 2009.	
2.	RaghavanV,PhysicalMetallurgy–Principles and Practice, Prentice Hall India Pvt.Ltd., NewDelhi,2006.	
REFERENCE BOOKS:		
1.	G.E.Dieter, Mechanical Metallurgy, McGraw Hill Publishing Co., New York, 1988.	
2.	O.P Khana, A test Book of Material Science & Metallurgy, Dhanpat Rai	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH17	**Placement Training & Skill Development Program - I**	**1**	2	**0**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
COURSE OBJECTIVES:	
1	To prepare the students write their project report
2	Get ready to write proposals implementing their ideas
3	To prepare them to speak in Public
4	To make them prepare effective Presentations and Enable students in Aptitude building
5	Enable students to use their Aptitude Knowledge effectively in decision making

UNIT	TITLE	PERIODS
1	**Report, Proposal, and Project**	**11**

Report Writing, Types, Structure, Style, and Writing of Reports (on different topics), Characteristics of Report, Categories and Types of Report, Types of Proposal, Nature, and Significance, Structure of formal Proposal, Sample Proposal, Writing Proposals on different topics, Difference between Report and Proposal,
Project Writing: Essential Features, Structure, Choosing the Subject, and Writing the Project on the related subject.

UNIT	TITLE	PERIODS
2	**Communication Skills**	**10**

Activities related to Skills required for Engineers (Managerial Skills, Leadership Skills, and Organizational Skills).
Recruitments and Interviews, Stages in Job Interview, Desirable Qualities, Reviewing the common Question Types of Interviews.

UNIT	TITLE	PERIODS
3	**Strategies for Recruitment**	**11**

Recruitments and Interviews, Stages in Job Interview, Desirable Qualities, Reviewing the Common Question Types of Interviews.

UNIT	TITLE	PERIODS
4	**Numbers and Arithmetic Basic**	**11**

Classification of Numbers, Divisibility rules –LCM/HCF, Remainders – Base System, Surds, Indices, Logarithms,
Percentage, Profit and Loss, Ratio and Proportion, Approximations, Vedic Maths, Intro to DI, Comprehensive Practice Test
on Number system, Percentage and Calculation,

UNIT	TITLE	PERIODS
5	**Simple Arithmetic:**	**11**

Code-decoding, Analogies, Direction Test, Blood relations ,Comprehension Practice test-1 (Cumulative) ,Comprehension Practice test-2 (Cumulative)

TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
CO1:	1. Students are trained to write the proposals and assigned projects
CO2:	3. Students write Presentations on different Industrial topics
CO3:	4. Improve arithmetic aptitude
CO4:	5. Learn tricks to solve Aptitude questions faster thereby saving time during competitive exams

REFERENCE COURSES/BOOKS:	
1	Sanjay Kumar and Pushp Lata 'Communication Skills', Oxford University Press 2012
2	Raymond Murphy 'Essential English Grammar', Cambridge University Press 1998
3	R. K. Narayan, Malgudi Days: A Collection of Short Stories, Penguin 2006
4	Meenakshi Raman and Prakash 'Business Communication' Oxford University Press 2011
5	Quantitative Aptitude for Competitive Examinations - Quantitative Aptitude by rs agrawal (English, Paperback, Aggarwal R. S.)
6	Meenakshi Raman and Sangeeta Sharma 'Technical Communication Principles and Practice', Oxford University Press 2012.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC13	**BIOENERGY AND SOLAR THERMAL LABORATORY**	**0**	**0**	**8**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

LIST OF EXPERIMENTS:

1. Study of Floating Drum Biogas Plants
2. Study of Fixed Drum Biogas Plants
3. Study of the Production Process of Biodiesel
4. Study of Production Process of Ethanol
5. Study of Production Process of Briquettes
6. Study of Solar Cookers
7. Study of Solar Water Heater
8. Study of Solar Dryer
9. Study of Solar Water Pumping System
10. Study of Solar Lighting System
11. Study of Solar Photovoltaic System
12. Visit to Renewable Energy Integrated Plant

TOTAL PERIODS :	**144**

Course Code	Course Title	Periods per week				
BVGPGSH18		L	T	P	R	Credits
	Innovative Design Thinking	**1**	**0**	**4**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1	To Learn how to develop an innovative design model.
2	To Identify, understand and discuss current, real-world issues.
3	To learn the best design solution among the potential solutions with its functional decomposition probability, and combinatorics.
4	To learn how to utilize the technical resources and to work in actual working environment.
5	To understand how to write the technical documents and give oral presentations related to the work completed.

Students are advised to create or innovate a product design matching the following objective: Instead of creating a new product and then "selling" it the public, innovative design is a process of identifying, pinpointing, and understanding the needs of the user or audience. What we need are new choices - new products that balance the needs of individuals and of society as a whole; new ideas and new strategies that tackle the global challenges of health, poverty, and education.

Each student has to identify the need of a product, synthesis, analyse, design, modify and select the best design.

Product Identification - Specification Development -Conceptual Design – 2D, 3D Part drawing Conduct of Functional Decomposition, Brain storming of possible solutions, process planning required for Prototypes, Refinement of Design Specification on users' feedback, Evaluation of Potential Solutions, Selection of best design.

The student will make an oral presentation followed by a brief question and answer session. The innovative design (presentation and report) will be evaluated by an internal assessment committee. Presentation will take place during weekly class session. Students have to make oral presentations periodically and finally submit a technical project report.

TOTAL PERIODS: 54

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

CO1:	develop an innovative design model
CO2:	Identify, understand and discuss current, real-world issues.
CO3:	Select the best design solution among the potential solutions with its functional decomposition probability, and combinatorics.
CO4:	utilize the technical resources and to work in actual working environment
CO5:	write technical documents and give oral presentations related to the work completed.

REFERENCE COURSES/BOOKS:	
1	https://www.ideo.com/
2	https://engineering.purdue.edu/EPICS
3	Yongxiang Lu, Yunhe Pan, Zhilei Xu "Innovative Design of Manufacturing" by Springer, 2020.

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVC14	**ELECTRIC VEHICLES**	**4**	**0**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn the fundamentals of Hybrid Electric Vehicle
2.	To learn the various Electric Drives
3.	To learn Energy Storage and Its working principles
4.	To learn Energy Management System
5.	To know the fundamentals of electrical vehicles

THEORY

UNIT	TITLE	PERIODS
1	**Introduction to Hybrid Electric Vehicle**	**14**

Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving

UNIT	TITLE	PERIODS
2	**Electric Drives**	**14**

Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor

UNIT	TITLE	PERIODS
3	**Energy Storage**	**15**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle

UNIT	TITLE	PERIODS
4	**Energy Management System**	**15**

Energy Management Strategies, Automotive networking and communication, EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges

UNIT	TITLE	PERIODS
5	**Mobility and Connectors**	**14**
Connected Mobility and Autonomous Mobility- case study Emobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Connectors- Types of EV charging connector, North American EV Plug Standards, DC Fast Charge EV Plug Standards in North America, CCS (Combined Charging System), CHAdeMO, Tesla, European EV Plug Standards,		
	TOTAL PERIODS:	**72**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	the fundamentals of Hybrid Electric Vehicle	
CO2:	the various Electric Drives and it working	
CO3:	How to do Energy Storage and Its working principles	
CO4:	The Energy Management System	
CO5:	the fundamentals of electrical vehicles	
TEXT BOOKS:		
1.	Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003	
2.	Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010	
REFERENCE BOOKS:		
1.	Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012	
2.	Tariq Muneer and Irene IllescasGarcía, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC15	POWER TRANSMISSION AND DISTRIBUTION	4	0	0	0	4

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn the fundamental of distribution systems
2.	To learn the transmission line parameters
3.	To learn performance of transmission lines
4.	To learn insulators and cables, recent trends in transmission
5.	To know about power transmission and power calculations

THEORY

UNIT	TITLE	PERIODS
1	DISTRIBUTION SYSTEMS	14

Structure of electric power systems - one Line Diagram - generation, transmission and distribution systems, comparison of distribution systems – radial and ring – two wire dc, ac single phase and three phase systems – current and voltage calculations in distributors with concentrated and distributed loads – Kelvin's law for the design of feeders and its limitations

UNIT	TITLE	PERIODS
2	TRANSMISSION LINE PARAMETERS	14

Resistance, inductance and capacitance of single and three phase transmission lines - symmetrical and unsymmetrical spacing – transposition - single and double circuits - stranded and bundled conductors - application of self and mutual GMD – Skin and Proximity effect - inductive interference - Corona - characteristics.

UNIT	TITLE	PERIODS
3	PERFORMANCE OF TRANSMISSION LINES	15

Development of equivalent circuits for short, medium and long lines – efficiency and regulation - attenuation constant and phase constant - surge impedance loading - power circle diagrams for sending and receiving ends - transmission capacity, steady state stability limit – voltage control of lines - shunt and series compensation.

UNIT	TITLE	PERIODS
4	INSULATORS AND CABLES	14

Insulators – types and comparison – voltage distribution in string insulator – string efficiency – methods of improving string efficiency – Stress and sag calculations – effect of wind and ice – supports at different levels – stinging chart - cables – types – capacitance of cables – insulation resistance - dielectric stress and grading - dielectric loss - thermal characteristics - capacitance of three core cables

UNIT	TITLE	PERIODS
5	**RECENT TRENDS IN TRANSMISSION**	15
Design of rural distribution, planning and design of town electrification schemes – comparison of EHVAC & HVDC system – economic distance for HVDC – terminal equipment for HVDC systems – description of DC transmission system – planning advantages-interconnection of HVDC & AC systems – Introduction to FACTS technology. Electric drives & Controller for e – vehicle lab		
	TOTAL PERIODS:	72
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	the fundamental of distribution systems	
CO2:	the transmission line parameters	
CO3:	The performance of transmission lines	
CO4:	The different insulators and cables, recent trends in transmission	
CO5:	about power transmission and power calculations	
TEXT BOOKS:		
1.	C.L . Wadhwa, Electrical Power Sytems, 5th edition, New Age International (P) Limited, New Delhi, 2006	
2.	V.K.Metha& Rohit Metha,"Principles of Power System", S.Chand,2005.	
REFERENCE BOOKS:		
1.	S.L.Uppal, Electrical Power, Khanna Publishers, New Delhi, 2002	
2.	Chakrabarti. A, Soni M I, Gupta P V, "Textbook on power system engineering", Dhanpat Rai & Co,2008.	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPVG06	MAINTENANCE AND SAFETY IN INDUSTRY	3	0	0	0	3

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn different types of maintenance
2.	To learn predictive maintenance & condition monitoring
3.	To learn about reliability
4.	To learn safety and productivity, safety codes and standards
5.	To know about safety codes in industries

THEORY

UNIT	TITLE	PERIODS
1	**TYPES OF MAINTENANCE**	11

Objectives of maintenance - types of maintenance – Breakdown, preventive and predictive maintenance
- Repair cycle - Repair Complexity, Lubrication system – Lubricants - inspection. Maintenance of Mechanical transmission systems - align machinery – static and dynamic balancing - process plants – air conditioning – water purification – environmental control.

UNIT	TITLE	PERIODS
2	**PREDICTIVE MAINTENANCE & CONDITION MONITORING**	10

Predictive Maintenance - vibration analysis data and noise as maintenance tool – wear debris analysis - Condition monitoring concepts applied to industries – diagnose faults – overhaul – testing and measurement using approved procedures - Total Productive Maintenance (TPM) - Economics of Maintenance- Computer aided maintenance – modern practice – modern manufacturing aspects.

UNIT	TITLE	PERIODS
3	**RELIABILITY**	11

Reliability: Definition, concept of reliability based design, failure rate, MTTF, MTBF, failure pattern, system reliability: Series, Parallel and Mixed configurations - Availability and Maintainability concepts- applications – electro, proportional and servo hydraulic components – shutdown machinery – isolation – dismantle – inspect – NDT - assembly – fans – pumps – valves – bearings – static – dynamic seals.

UNIT	TITLE	PERIODS
4	**SAFETY AND PRODUCTIVITY**	11

Safety and productivity - causes of accidents in industries – accident reporting and investigation - measuring safety performance - Safety organizations and functions - Factories act and rules - Manufacture, Storage and Import of Hazardous Chemical rules - Explosive act - Gas cylinder rules – Electricity act.

UNIT	TITLE	PERIODS
5	**SAFETY CODES AND STANDARDS**	11
Safety Codes and Standards – Air Quality – indoor - outdoor – safe drinking water - General Safety considerations in Material Handling equipments - Machine Shop machineries-pressure vessels and pressurized pipelines – IBR - welding equipments – operation and inspection of extinguishers – prevention and spread of fire – emergency exit facilities - NFPA Standards – ISO 14000.		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Types of maintenance	
CO2:	Predictive maintenance & condition monitoring	
CO3:	Reliability	
CO4:	Safety and productivity, safety codes and standards	
CO5:	To learn safety and productivity, safety codes and standards	
TEXT BOOKS:		
1.	Gopalakrishnan, P. and Banerji, A. K., Maintenance and Spare Parts Management, PHI Learning Pvt. Ltd., New Delhi, 2013.	
2.	Venkataraman .K ―Maintancence Engineering and Management‖, PHI Learning, Pvt. Ltd., 2007.	
REFERENCE BOOKS:		
1.	Garg, H.P., Industrial Maintenance, S.Chand& Co Ltd., New Delhi, 1990	
2.	Patrick D. T. O'Connor – Practical Reliability Engineering, Wiley, 2008.	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH19	**Placement Training & Skill Development Program - II**	**1**	**2**	**0**	**0**	**3**

PREREQUISITES:		
NIL / Course Code – Course Title / Topics		
COURSE OBJECTIVES:		
1	To prepare the students, think critically.	
2	To prepare the get ready for aptitude exams	
3	To Improve communication skills.	
4	To learn and Develop a synthesizing mind.	
5	To prepare about group discussions	
UNIT	**TITLE**	**PERIODS**
1	**Group discussions:**	**11**
Advantages of group discussion, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques		
UNIT	**TITLE**	**PERIODS**
2	**Reading comprehension advanced**	**11**
A course on how to approach middle level reading comprehension passages.		
UNIT	**TITLE**	**PERIODS**
3	**Problem solving**	**11**
Money-related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic, and polynomial equations;special equations; Inequalities; Functions and graphs; Sequence and series;		
UNIT	**TITLE**	**PERIODS**
4	**Aptitude**	**10**
Set theory; Permutations and combinations;Probability; Statistics, Time speed and distance ,work time problems.		
UNIT	**TITLE**	**PERIODS**
5	**Non-verbal reasoning, simple engineering aptitude and**	**11**
Mirror image, Water image, Paper folding, Paper cutting, Grouping of figures, Figure formation and analysis, Completion of incomplete pattern		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to:		
CO1:	Communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation.They would further develop their interpersonal and leadership skills.	
CO2:	Examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arriving at a consensus.	
CO3:	Identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability, and combinatorics.	

CO4:	Relate, choose, conclude and determine the usage of right vocabulary
REFERENCE COURSES/BOOKS:	
1	The Hard Truth about Placement Trainings, by Amazone Publication.
2	Quantitative Aptitude by R. S. Aggarwal,S. Chand, Abijith Guha, TMH, Arun Sharma.
3	Gulati. S., (2006) "Corporate Placement Trainings", New Delhi, India: Rupa & Co.
4	A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVC16	**ELECTRIC DRIVES & CONTROLLER FOR E – VEHICLE LAB**	0	0	8	0	4
PREREQUISITES:						
NIL / Course Code – Course Title / Topics						
LIST OF EXPERIMENTS:						
1. Testing of batteries & battery maintenance 2. Testing of starter motor and alternator 3. Diagnosis of ignition system faults 4. Wiring of head light, traffic, and electric horn 5. Characteristics of rectifiers and filters 6. Study of IC timer 7. Relay & fuse fault diagnostic of a car using OBDS 8. Assembling of e bicycle.						
TOTAL PERIODS :	**144**					

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGPGSH20	**Integral Yoga & Values-based Life and Leadership for Human Unity- III**	**1**	**0**	**4**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1	To learn Radical Transformational Leadership tools to apply what I stand for (care about) in my everyday practice.
2	To learn systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment.
3	To learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

UNIT	TITLE	PERIODS
1	**Triple birth: The Threefold of Life**	**6**

Threefold potentialities of man- material man, mental man & spiritual man; Material and spiritual life in India; Collective perfection

UNIT	TITLE	PERIODS
2	**The Systems of Yoga**	**6**

Three consenting parties & Omnipresent Trinity; Hata yoga, raja yoga, bhakti yoga, jnana yoga, karma yoga

UNIT	TITLE	PERIODS
3	**The Synthesis of Systems**	**6**

Meaning of synthesis; Synthesis in Integral Yoga and Aim of Integral Yoga

LABORATORY

UNIT	TITLE	PERIODS
1	**Embodying Distinctions**	**72**

(i) Intersession 2: learning about self for social transformation
(ii) Stages of Leadership
(iii) Integrity Lens
(iv) Three domains of Listening & Speaking
(v) Story of Solutions – Creating Criteria
(vi) Reviewing my BTI- CSFR and Respond & Realize; Synergistic Operational Strategies & Transformational Results Chain
(vii) Creating transformational spaces in routine activities: meetings
(viii) Interrupting disempowering ISMs
(ix) Aligning projects for Synergy based on my BTI
(x) Emotional reactions distinguished from courageous heart response
(xi) Strategic Action & Results at Scale
(xii) Fruition Time for Results
(xiii) Synergistic Partnerships for Results- using Likert Emberling Framework
(xiv) Transformational Listening and speaking: My Project, & what I will do to break disempowering ISMS- Groups of 6

TOTAL PERIODS:	**90**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to:	
CO1:	apply Radical Transformational Leadership tools in what I stand for (care about) in my everyday practice.
CO2:	develop systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment.
CO3:	learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential
REFERENCE BOOKS/ COURSES:	
1	Monica Sharma. (2017). Radical Transformational Leadership: Strategic Action for Change, North Atlantic Publishing, at Berkeley, California

ELECTIVE PAPERS:

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVE01	**ENERGY, ENVIRONMENT AND RENEWABLE ENERGY TECHNOLOGIES**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn about green Energy
2.	To know about Ecology and Environment
3.	To learn about Renewable Sources of Energy
4.	To learn the fundamentals of Bioenergy, Other Energy Sources and Systems
5.	To know about environment and renewable energy technologies

THEORY

UNIT	TITLE	PERIODS
1	**Energy**	**11**

Introduction to the nexus between energy, environment and sustainable development, Energy sources over view and classification, sun as the source of energy, fossil fuel reserves and resources - overview of global/ India's energy scenario. Energy consumption models – Specific Energy Consumption

UNIT	TITLE	PERIODS
2	**Ecology and Environment**	**10**

Concept and theories of ecosystems, - energy flow in major man-made ecosystems- agricultural, industrial and urban ecosystems - sources of pollution from energy technologies and its impact on atmosphere - air, water, soil, and environment - environmental laws on pollution control, The environmental protection act :Effluent standards and ambient air quality, innovation and sustainability, eco-restoration: phyto-remediation.

UNIT	TITLE	PERIODS
3	**Renewable Sources of Energy**	**11**

Solar Energy: Solar radiation: measurements and prediction. Indian's solar energy potential and challenges, solar energy conversion principles and technologies: Photosynthesis, Photovoltaic conversion and Photo thermal energy conversion. Wind Energy: Atmospheric circulations, atmospheric boundary layers, classification, factors influencing wind, wind shear, turbulence, wind energy basics and power Content, wind speed monitoring, Betz limit, wind energy conversion system: classification, characteristics and applications. Ocean Energy: Ocean energy resources-ocean energy conversion principles and technologies: ocean thermal, ocean wave & ocean tide

UNIT	TITLE	PERIODS
4	**Bioenergy**	**11**

Biomass as energy resources; bio-energy potential and challenges, Classification and estimation of biomass; Source and characteristics of biofuels: Biodiesel, Bioethanol, Biogas. Types of biomass energy conversion systems - waste to energy conversion technologies

UNIT	TITLE	PERIODS
5	**Other Energy Sources and Systems**	**11**
Hydropower, Nuclear fission and fusion-Geothermal energy: Origin, types of geothermal energy sites, site selection, geothermal power plants; hydrogen energy, Magneto-hydro-dynamic (MHD) energy conversion – Radioisotope Thermoelectric Generator (RTG), Bio-solar cells, battery & super capacitor, energy transmission and conversions.		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Understand the nexus between energy, environment and sustainable development	
CO2:	Appreciate energy ecosystems and its impact on environment	
CO3:	Learn basics of various types of renewable and clean energy technologies	
CO4:	Serve as bridge to advanced courses in renewable energy	
TEXT BOOKS:		
1.	Energy and EnvironmentSet: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean- Philippe; Zaccour, Georges (Eds.), 2005.	
2.	Energy and the Environment, Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., 2nd Edition, John Wiley, 2006	
REFERENCE BOOKS:		
1.	Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000	
2.	D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.	

Course Code	Course Title	Periods per week				Credits
		L	**T**	**P**	**R**	
BVGEVE02	**BIOMASS FEEDSTOCK AND SOLID BIOFUEL PRODUCTION**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
Course Objective	
1.	To learn the various Biomass Resources
2.	To learn Resource Assessment of Biomass
3.	To learn Processing of Biomass
4.	To learn Solid Biofuel Production Processes
5.	To learn Energy Economy of solid biofuel

THEORY

UNIT	**TITLE**	**PERIODS**
1	Biomass Resources:	**10**

Biomass Resources: Agricultural produce and waste biomass, Biomass from forest produce and energy plantation. Biomass yield, availability, energy potential. Industrial biomass, Biomass from urban and municipal wastes.

UNIT	**TITLE**	**PERIODS**
2	Resource Assessment of Biomass:	**11**

Interaction of biomass with electromagnetic spectrum –Principle of remote sensing and its application to biomass quantification - Vegetation indices - Analysis of satellite imageries for biomass quantification. Biomass feedstock potential in India - Regional biomass availability - Case studies.

UNIT	**TITLE**	**PERIODS**
3	Processing of Biomass:	**11**

Physical properties of biomass: Moisture, bulk density, size, grindability, crushability. Chemical composition of biomass- estimation of volatile matter, cellulose and lignin content. Properties of municipal solid waste – MSW management principle – Segregation of waste biomass – refuse derived fuels. Pelleting and briquetting of solid biomass – Process flow – factors influencing heat values. Pretreatment of biomass for energy enhancement – Torrefaction

UNIT	**TITLE**	**PERIODS**
4	Solid Biofuel Production Processes:	**11**

Fuel characteristics of solid biofuels - co-firing in thermal power plants – application in industrial units, Industrial production of pellets and briquettes – Integrated process flow - feedstock and product portfolios – Seasonal biomass feedstock – Securing feedstock supply chain.

UNIT	TITLE	PERIODS
5	Energy Economy of solid biofuel:	**11**
Roll of biomass energy in energy security - energy economy of solid biofuel - regional biomass utilization-Entrepreneurships potential- International and national energy policies on solid biofuel – Integrated economy model in Solid Biofuel Production – Case studies.		
	TOTAL PERIODS:	**54**
COURSE OUTCOMES:		
Upon completion of this course, students will be able to know:		
CO1:	Student shall able to assess regional biomass potential for energy conversion	
CO2:	Learn the processes and technology to develop solid biofuel from available biomass	
CO3:	Learn various solid biofuel processing processes and their commercial potential.	
TEXT BOOKS:		
1.	Industrial briquetting: fundamentals and methods, Vol.13. Studies in Mechanical Engineering by ZygmuntDrzymała, Elsevier, 1993.	
2.	Biomass Briquetting: Technology and Practices by P.D.Grover&S.K.Mishra, published by FAO Regional Wood Energy Development Programme in Asia,Bangkok, Thailand	
REFERENCE BOOKS:		
1.	Chakraverthy A, "Biotechnology and Alternative Technologies for Utilization of Biomass OrAgricultural Wastes", Oxford & IBH publishing Co, 1989	
2.	Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", Tata Energy Research Institute, 1996	

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVE03	**WIND ENERGY & SMALL HYDROPOWER SYSTEMS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn the fundamentals of Wind Energy Potential
2.	To learn about Wind Energy Conversion
3.	To learn about WECS Design Considerations
4.	To learn and know about Wind Energy Application
5.	To learn Small Hydropower Systems

THEORY

UNIT	TITLE	PERIODS
1	**Wind Energy Potential**	**11**

Wind Velocity Distribution – Estimation of wind resource – Wind Indian and Global scenario

UNIT	TITLE	PERIODS
2	**Wind Energy Conversion**	**11**

Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and Strip theory; Maximum power coefficient; Prandlt's tip loss correction; Rotor design and characteristics; Power, torque and speed characteristics – Wind turbine performance measurement – Loading analysis.

UNIT	TITLE	PERIODS
3	**WECS Design Considerations**	**11**

Design of WECS components – Stall, pitch & yaw control mechanisms – Brake control mechanisms; Theoretical simulation of wind turbine characteristics; Test methods.

UNIT	TITLE	PERIODS
4	**Wind Energy Application**	**10**

Wind pumps: Performance analysis, design concept and testing; Principle of Wind Energy Generators; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies: build small wind turbine

UNIT	TITLE	PERIODS
5	**Small Hydropower Systems**	**11**

Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works; Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in India. Case studies: build small hydro turbine

TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to know:	
CO1:	Wind Energy Potential
CO2:	Wind Energy Conversion
CO3:	WECS Design Considerations
CO4:	Wind Energy Application
CO5:	Small Hydropower Systems
TEXT BOOKS:	
1.	Wind Energy Explained: Theory, Design and Application, by J. F. Manwell, ISBN:9780470015001, Publisher: John Wiley & Sons, Publication Date: February 2010
2.	Introduction to Wind Energy Systems: Basics, Technology and Operation (Green Energy and Technology), by Hermann-josef Wagner, ISBN: 9783642020223, Publisher: Springer, September 2009.
REFERENCE BOOKS:	
1.	Wind Energy (Fueling the Future), by Lola Schaefer, ISBN:9781432915728, Publisher:Heinemann Educational Books, 2008.
2.	Wind Turbines: Fundamentals, Technologies, Application and Economics, Erich Hau , Springer Verlag; (2000)

Course Code	Course Title	Periods per week				Credits
	WASTE TO ENERGY	**L**	**T**	**P**	**R**	
BVGEVE04	**CONVERSION**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	Know about Waste & Waste processing
2.	To learn about Waste treatment and disposal
3.	To know about Environmental and health impacts-case studies
4.	To learn about Energy from waste- Bio-chemical conversion
5.	To know about Energy from waste-thermo chemical conversion

THEORY

UNIT	TITLE	PERIODS
1	**Introduction to Waste & Waste processing:**	**10**

Definitions, sources, types and composition of various types of wastes; Characterization of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW), waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), recycling processes of solid waste.

UNIT	TITLE	PERIODS
2	**Waste treatment and disposal**	**11**

Aerobic composting, incineration, different type of incineration; medical and pharmaceutical waste incinerations- land fill 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

UNIT	TITLE	PERIODS
3	**Environmental and health impacts-case studies**	**11**

Environmental and health impacts of waste to energy conversion, case studies of commercial waste to energy plants, waste to energy- potentials and constraints in India, eco-technological alternatives for waste to energy conversions - Rules related to the handling, treatment and disposal of MSW and BMW in India.

UNIT	TITLE	PERIODS
4	**Energy from waste- Bio-chemical conversion**	**11**

Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion- biogas production, land fill gas 25 generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages.

UNIT	TITLE	PERIODS
5	**Energy from waste-thermo chemical conversion**	**11**

Sources of energy generation, incineration, pyrolysis, gasification of waste using gasifiers, briquetting, utilization and advantages of briquetting,-environmental and health impacts of incineration; strategies for reducing environmental impacts.

TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to know:	
CO1:	Learn fundamentals of solid waste generation and its management techniques
CO2:	Acquire knowledge on various waste treatments and disposal processes.
CO3:	Student shall learn to appreciate importance of waste-to-energy and waste management hierarchy for all kinds of wastes materials.
CO4:	Learn to assess environmental and health impacts of various waste-to-energy conversion technologies with case studies.
TEXT BOOKS:	
1.	Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, 2010.
2.	Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1-57808-200-1; 2002
REFERENCE BOOKS:	
1.	Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
2.	Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsiever, ISBN-13: 978-0-8155-1132-8, ISBN-10: 0- 8155-1132-9

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
BVGEVE05	**NANOTECHNOLOGY FOR ENERGY SYSTEMS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

Course Objective

1.	To learn Nano-electronics and its applications
2.	To learn about Physical Properties of Nanosystems
3.	To learn about Nanotechnology for Energy Efficient Devices
4.	To learn about Nanotechnology for Energy Storage
5.	To learn about Nanotechnology for Solar Energy Conversion

THEORY

UNIT	TITLE	PERIODS
1	Nano-electronics	**11**

Concept of wave-matter duality, phase and group velocities, electron state in solids, uncertainty principle, operators, quantum mechanical postulates, Schrödinger's Wave Equation, free electron gas, spherical, electron in spherical potential (hydrogen atom), Hydrogen molecule, Atom by Atom arrangements , band structure formation, E-k diagram, electronic states of 2-D, 1-D, 0-D nanosystems.

UNIT	TITLE	PERIODS
2	Physical Properties of Nanosystems	**11**

Light absorption in Nano systems, size dependence and material dependence of absorption, band gap engineering, Fermi-level, ballistic and diffusive transport in nanosystems, coulomb blockade, resonant tunnelling, carrier separation techniques

UNIT	TITLE	PERIODS
3	Nanotechnology for Energy Efficient Devices	**11**

Energy efficient devices –fabrication and applications of quantum well LED as light device, – optical amplifiers, quantum well lasers, optical switch, Quantum dot luminescence materials.

UNIT	TITLE	PERIODS
4	Nanotechnology for Energy Storage	**10**

Nanostructured electrodes fabrication, nanotubes for energy storage, nanotechnology for electrochemical storage, Nanotechnology for conversion of solar energy to hydrogen

UNIT	TITLE	PERIODS
5	Nanotechnology for Solar Energy Conversion	**11**

Challenges in energy conversion – role of nanostructures & materials – nanomaterials in solar Photovoltaic Technology: quantum well solar cell, quantum wire solar cell, quantum dot solar cell – quantum dot sensitized solar cell, photo-current calculation. Tandem structures – nanotechnology 34 for solar thermal fuels, nanotubes for solar energy harvesting, Concept of photo-electro chemical cell.

TOTAL PERIODS:	**54**

COURSE OUTCOMES:	
Upon completion of this course, students will be able to know:	
CO1:	Nano-electronics
CO2:	Physical Properties of Nanosystems
CO3:	Nanotechnology for Energy Efficient Devices
CO4:	Nanotechnology for Energy Storage
CO5:	Nanotechnology for Solar Energy Conversion
TEXT BOOKS:	
1.	Quantum Chemistry, Levine, Prentice Hall
2.	Statistical Mechanics and properties of matter, E.S.R Gopal, Ellis Horwood
REFERENCE BOOKS:	
1.	Introduction to solids, Azaroff, Tat Mc-Graw Hill
2.	Physical principles of micro Micro-electronics, G.Yepifanov, Mir Publishers, 1974, 1st Edition