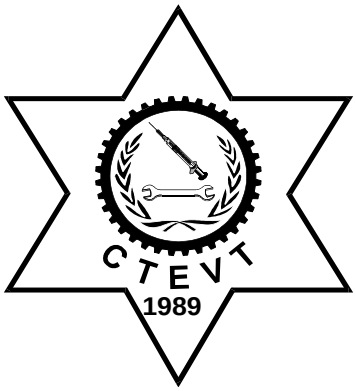
CURRICULUM

Diploma
Refrigeration and Air-Conditioning Engineering

(Three years program-semester system)



Council for Technical Education and Vocational Training
Curriculum Development & Equivalence Division
Sanothimi, Bhaktapur
2015
First Revision 2022

Contents

Introduction

Refrigeration and Air Conditioning Engineering is one of the prominent disciplines in engineering sector. Many people in the developed countries, developing countries and under developed countries have emphasized for the broader application of Refrigeration and Air Conditioning Engineering. This has been creating wage and self-employment opportunities both in public and private sectors. This curriculum is based on the academic requirements to enter bachelor as well as designed with the purpose of producing middle level technical workforce equipped with knowledge and skills related to the field of mechanical engineering, especially in Refrigeration and Air Conditioning engineering so as to meet the demand of such workforce in the country to contribute the development in the country. The knowledge and skills incorporated in this curriculum will be helpful to deliver the individual needs as well as national and international needs in the field of Refrigeration and Air Conditioning sector.

This course is based on the job required to perform by the Refrigeration and Air Conditioning Engineering Technicians (Ref and AC Sub-Engineer) at different levels of public and private sectors. There are six semesters in total in three year's course duration. The first year course focuses on foundational and core subjects of engineering; the second year course focuses on basic disciplinary subjects of Mechanical Engineering and Refrigeration and Air Conditioning Engineering. Similarly, the third year whole courses comprise of the disciplinary subjects including provision of elective subjects. Moreover, the third year insists on the application of learned skills and knowledge through the industrial attachment and major project.

The foundational subjects like Physics, Chemistry, and Mathematics are offered in diffusion model of curricular programme. It also includes language subjects like Nepali and English applicable for the communication in the same area. The disciplinary subjects of Refrigeration and Air Conditioning Engineering are offered in this programme are included in all semesters. This curricular programme also makes provision of Industrial attachment, project works as well as elective subjects in the specific areas of Refrigeration and Air Conditioning Engineering. The curriculum structure and the subject wise content that reflect the details of this curriculum. In brief, this curriculum will guide to its implementers to produce competent and highly employable technical workforces in the field of Refrigeration and Air Conditioning Engineering.

Rationale of Revision

Diploma in Refrigeration and Air Conditioning Engineering curriculum was developed in 2015. This is the First revision after the implementation of development. The rationales behind its revision are as follows:

- It crossed the 5 years period of its implementation after development and similarly the implementing agencies/college have requested to revise this curriculum based on their teaching experiences.
- The year-wise re-adjustments of the existing subjects are felt necessary.
- Some new subjects seem to be introduce as per the advancement in technology.
- It is needed to revisit its weightage in both theory and practical marks and contents to make it more practical oriented.

Furthermore, technology of Refrigeration and Air Conditioning occupation upgraded rapidly and new technology are introducing in the recent year. With the advent in technology trained

technicians are needed throughout the world. To cope with the national and international demand, the knowledge and the skills should be updated to make the skills relevant and pertinent to the industry. Hence this curriculum is revised to equip the students as per the changing technology in changing environmental context.

Curriculum title
Diploma in Refrigeration and Air-conditioning Engineering (DRAE).

Aim
The program aims to produce mid-level technical human resource equipped with knowledge and skills in allied field of study.

Objectives
This curriculum has following objectives:

1. Prepare mid-level competent workforce in the related field.
2. Prepare such technicians who are able to work in the automobile sector related local workshop and industrial settings of the country.
3. Meet the demand of such technical workforce for the automobile industries of Nepal.
4. Reduce the dependence on employing such technicians from foreign countries.
5. Prepare technical workforce demonstrating positive attitude and respect for the profession and socio-cultural values.
6. Create self-employment opportunities.

Group Size
The group size is a maximum of 48 students.

Entry Criteria

- SLC pass or SEE or equivalent with minimum C Grade (2.0 Grade Point) in Mathematics and Science and 1.6 Grade Point or equivalent in English and as per the provisions mentioned in the admission guidelines of Office of the Controller of Examinations, CTEVT.
- Pre-diploma in related subject or equivalent with minimum 68.33%.
- Pass entrance examination administered by CTEVT.

Duration
The total duration of this curricular program is three years. Each year consists of two semesters of six months each. Moreover, one semester consists of 19.5 academic weeks including evaluation period. Actual teaching learning Hrs will be not less than 15 weeks in each semester.

Medium of Instruction
The medium of instruction will be in English and/or Nepali.

Pattern of Attendance
Minimum of 90% attendance in each subject is required to appear in the respective final examination.

Teacher (Instructor) and Student Ratio

The ratio between teachers and students must be:

- Overall ratio of teacher and student must be 1:12 (at the institution level)
- 1:48 for theory and tutorial classes
- 1:12 for practical classes
- 1:8 for bench work
- 75 % of the technical teachers should be full timer

Qualification of Instructional Staff

- The program coordinator should be a master's degree holder in the related subject area.
- The disciplinary subject related teachers should be a bachelor's degree holder in the related subject area.
- The demonstrators should be a bachelor's degree holder or diploma or equivalent with 3 years work experience in the related subject area.
- The foundational subject related teacher (refer to course codes SH and MG) should be master's degree holder in the related subject area.

Instructional Media and Materials

The following instructional media and materials are suggested for the effective instruction and demonstration.

- ***Printed media materials:*** Assignment sheets, case studies, handouts, performance checklists, textbooks etc.
- ***Non-project media materials:*** Displays, models, photographs, flipchart, poster, writing board etc.
- ***Projected media materials****:* Slides, Multimedia Projector.
- ***Audio-visual materials:*** Audiotapes, films, slide-tapes, videodisc, etc.
- ***Computer based instructional materials:*** Computer based training, interactive video etc.
- **Web-Based Instructional Materials** (Online learning)
- **Radio/Television/Telephone**
- **Education-focused social media platform**

Teaching Learning Methodologies

The methods of teachings for this curricular program will be a combination of several approaches such as; illustrated lecture, tutorial, group discussion, demonstration, simulation, guided practice, fieldwork, block study, industrial practice, report writing, term paper presentation, heuristic and other independent learning exercises.

- **Theory**: Lecture, Group discussion, assignment and group work etc.
- **Practical**: Demonstration, observation and self-practice.
- **Internship**: Industrial Practice.

Approach of Learning

There will be inductive, deductive and learner-centered approaches of learning.

Examination and Marking Scheme

a. Internal assessment

- There will be a transparent/fair evaluation system for each subject in both theory and practical exposure.

- Each subject will have internal assessment at regular intervals and students will get the feedback about it.
- Weightage of theory and practical marks are mentioned in curriculum structure.
- Continuous assessment format will be developed and applied by the evaluators for evaluating student's performance in the subjects related to the practical experience.

b. Final examination

- Weightage of theory and practical marks are mentioned in structure.
- Students must pass in all subjects both in theory and practical for certification. If a student becomes unable to succeed in any subject s/he will appear in the re-examination administered by CTEVT.
- Students will be allowed to appear in the final examination only after completing the internal assessment requirements.

c. Requirement for final practical examination

- Professional of relevant subject teacher must evaluate final practical examinations.
- One evaluator in one setting can evaluate not more than 24 students.
- Practical examination should be administered in actual situation on relevant subject with the provision of at least one internal evaluator from the concerned constituent or affiliated institute led by external evaluator nominated by CTEVT.
- Provision of re-examination will be as per CTEVT policy.

d. Final practicum evaluation will be based on

- Institutional practicum attendance - 10%
- Logbook/Practicum book maintenance - 10%
- Spot performance (assigned task/practicum performance/identification/arrangement preparation/measurement) - 40%
- Viva voce :
  - Internal examiner - 20%
  - External examiner - 20%

e. Pass marks

- The students must secure minimum 40% marks in theory and 50% marks in practical. Moreover, the students must secure minimum pass marks in the internal assessment and in the semester final examination of each subject to pass the subject.

Provision of Back Paper

There will be the provision of back paper but a student must pass all the subjects of all year within six years from the enrollment date; however, there should be provision of chance exam for final year students as per CTEVT rules.

Disciplinary and Ethical Requirements

- Intoxication, insubordination or rudeness to peers will result in immediate suspension followed by the review of the disciplinary review committee of the institute.
- Dishonesty in academic or practical activities will result in immediate suspension followed by administrative review, with possible expulsion.

- Illicit drug use, bearing arms in institute, threats or assaults to peers, faculty or staff will result in immediate suspension, followed by administrative review with possible expulsion.

Grading System

The grading system will be as follows:

Grading	**Overall marks**
• Distinction:	80% and above
• First division:	65% to below 80%
• Second division:	50 % to below 65%
• Pass division:	Pass marks to Below 50%

Certificate Awarded

- Students who have passed all the components of all subjects of all 3 years are considered to have successfully completed the course.
- Students who have successfully completed the course will be awarded with a degree of **"Diploma in Refrigeration and Air-Conditioning Engineering"**.

Career Path

The graduates will be eligible for the position equivalent to Non-gazetted 1st class/Level 5 (technical) as prescribed by the Public Service Commission of Nepal and other related agencies.

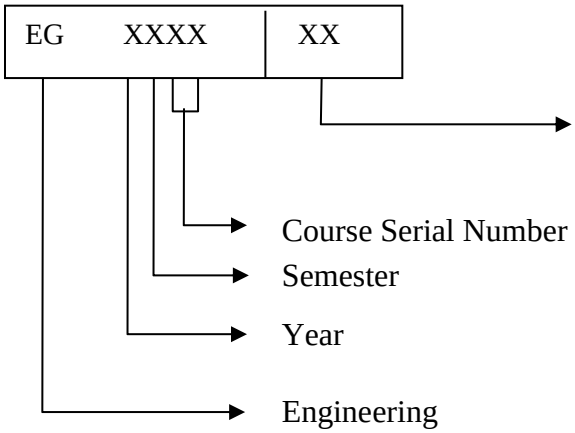
General Attitudes Required

A student should demonstrate following general attitudes for effective and active learning.

Acceptance, Affectionate, Ambitious, Aspiring, Candid, Caring, Change, Cheerful, Considerate, Cooperative, Courageous, Decisive, Determined, Devoted, Embraces, Endurance, Enthusiastic, Expansive, Faith, Flexible, Gloomy, Motivated, Perseverance, Thoughtful, Forgiving, Freedom, Friendly, Focused, Frugal, Generous, Goodwill, Grateful, Hardworking, Honest, Humble, Interested, Involved, Not jealous, Kind, Mature, Open minded, Tolerant, Optimistic, Positive, Practical, Punctual, Realistic, Reliable, Distant, Responsibility, Responsive, Responsible, Self-confident, Self-directed, Self-disciplined, Self-esteem, Self-giving, Self-reliant, Selfless, Sensitive, Serious, Sincere, Social independence, Sympathetic, Accepts others points of view, Thoughtful towards others, Trusting, Unpretentiousness, Unselfish, Willingness and Work-oriented.

Subjects codes:

Each subject is coded with a unique number preceded and followed by certain letters as mentioned in the following chart:



Code of Offering Diploma Programmes:

1. AGE: Agricultural Engineering
2. AR: Architecture Engineering
3. AE: Automobile Engineering
4. BM: Biomedical Engineering
5. BM: Biomedical Equipment Engineering
6. CE: Civil Engineering
7. CT: Computer Engineering
8. EE: Electrical Engineering
9. EEX: Electrical & Electronics Engineering
10. EX: Electronics Engineering
11. GE: Geomatics Engineering
12. HE: Hydropower Engineering
13. IT: Information Technology
14. MG: Management
15. ME: Mechanical Engineering
16. MX: Mechatronics Engineering
17. RAE: Refrigeration & Air Conditioning Engineering
18. SH: Science and Humanities

CURRICULUM STRUCTURE

Diploma in Refrigeration and Air Conditioning Engineering

YEAR: I **PART I**

S.N	Code No.	Subjects	Teaching Scheme						Examination Scheme						Total Marks	Remarks
			Mode				Weekly Hrs	Credit Hrs	DISTRIBUTION OF MARKS							
									Theory			Practical				
			L	T	P	Lab			*Assmt Marks	Final Marks	Time Hrs	*Assmt Marks	Final Marks	Time Hrs		
1	EG 1101 SH	Applied Nepali	4				4	4	20	80	3				100	*Continuous assessment
2	EG 1102 SH	Applied English	4				4	4	20	80	3				100	
3	EG 1103 SH	Engineering Mathematics I	4	2			6	4	20	80	3				100	
4	EG 1104 SH	Engineering Physics I	4	2		2	8	4	20	60	3	10	10	2	100	
5	EG 1105 SH	Engineering Chemistry I	4	2		2	8	4	20	60	3	10	10	2	100	
6	EG 1101 AR	Engineering Drawing I	1		4		5	4				60	40	4	100	
7	EG 1101 CT	Computer Application	2		2		4	4	10	40	1.5	30	20	3	100	
TOTAL			**17**	**8**	**10**	**5**	**40**	**28**	**110**	**400**		**110**	**80**		**700**	

YEAR: I **PART II**

S.N	Code No.	Subjects	Teaching Scheme						Examination Scheme						Total Marks	Remarks
			Mode				Weekly Hrs	Credit Hrs	DISTRIBUTION OF MARKS							
									Theory			Practical				
			L	T	P	Lab			*Assmt Marks	Final Marks	Time Hrs	*Assmt Marks	Final Marks	Time Hrs		
1	EG 1201 SH	Engineering Mathematics II	4	2			6	4	20	80	3				100	*Continuous assessment
2	EG 1202 SH	Engineering Physics II	4	2		2	8	5	20	60	3	10	10	2	100	
3	EG 1203 SH	Engineering Chemistry II	4	2		2	8	5	20	60	3	10	10	2	100	
4	EG 1201 CE	Workshop Practice I	2		6		8	5	0	0		60	40	4	100	
5	EG 1201 AR	Engineering Drawing II	0		4		4	2	0	0		60	40	4	100	
6	EG 1202 CE	Applied Mechanics	3	2		2/2	6	4	20	60	3	20	0		100	
TOTAL			**17**	**8**	**10**	**5**	**40**	**25**							**600**	

Diploma in Refrigeration and Air Conditioning Engineering

YEAR: II **PART: I**

SN	Course Code	Course Title	Teaching Scheme						Evaluation Scheme						Total Marks	Remark
			Mode				Total Hour	Credit Hours	DISTRIBUTION OF MARKS							
			L	T	P	Lab			Theory			Practical				
									*Assmt Marks	Final Marks	Exam Hours	*Assmt Marks	Final Marks	Exam Hours		
1	EG 2101 ME	Basic Electronics Engineering	3			2	5	4	20	80	3	25			125	*Continuous assessment
2	EG 2102 ME	Electrical Technology	3			2	5	4	20	80	3	25			125	
3	EG 2105 ME	Thermal Engineering	3	1		2/2	5	4	20	80	3	25			125	
4	EG 2101 RAE	Workshop Practice II	3		8		11	7	20	80	3	120	80	6	300	
5	EG 2102 RAE	Refrigeration I	3	1	4		8	5	20	80	3	60	40	4	200	
6	EG 2103 RAE	Electrical Installation	1		5		6	4				100	50	4	150	
		TOTAL	**16**	**2**	**17**	**5**	**40**	**28**							**1025**	

YEAR: II **PART: II**

SN	Course Code	Course Title	Teaching Scheme						Evaluation Scheme						Total Marks	Remark
			Mode				Total Hour	Credit Hours	DISTRIBUTION OF MARKS							
			L	T	P	Lab			Theory			Practical				
									*Assmt Marks	Final Marks	Exam Hours	*Assmt Marks	Final Marks	Exam Hours		
1	EG 2201 RAE	Instrumentation and Control System	3			2	5	4	20	80	3	25			125	*Continuous assessment
2	EG 2202 RAE	Applied Electronics	4			2	6	5	20	80	3	25			125	
3	EG 2203 RAE	Refrigeration II	3	1	4		8	5	20	80	3	60	40	4	200	
4	EG 2204 RAE	Heating Ventilation and Air Conditioning I	3	1	3		7	5	20	80	3	60	40	4	200	
5	EG 2206 ME	Fluid Mechanics and Machines	3	1		2/2	5	4	20	80	33	25			125	
6	EG 2205 RAE	Mechanics of Materials	3	1		2/2	5	4	20	80		25			125	
7	EG 2206 RAE	Machine Drawing	1		3		4	3				60	40	4	100	
		Total =	**20**	**4**	**10**	**6**	**40**	**30**							**1000**	

Diploma in Refrigeration and Air Conditioning Engineering

YEAR: III **PART: I**

SN	Course Code	Course Title	Teaching Scheme						Evaluation Scheme						Total Marks	Remark
			Mode				Total Hour	Credit Hours	DISTRIBUTION OF MARKS							
									Theory			Practical				
			L	T	P	Lab			*Assmt Marks	Final Marks	Exam Hours	*Assmt Marks	Final Marks	Exam Hours		
1	EG 3101 RAE	Refrigeration III	3	1	4		8	5	20	80	3	60	40	4	200	*Continuous assessment
2	EG 3102 RAE	Heating Ventilation and Air Conditioning II	3	1	3		7	5	20	80	3	60	40	4	200	
3	EG 3103 RAE	Industrial Engineering	3				3	5	20	80	3				100	
4	EG 3104 RAE	Trouble Shooting and Maintenance	1		5		6	5				100	50	4	150	
5	EG 3105 RAE	Computer Aided Drawing	1		3		4	3				60	40	4	100	
6	EG 3106 RAE	Industrial Attachment			12		12	6				240	160	8	400	
		TOTAL	**11**	**2**	**27**		**40**	**29**							**1150**	

YEAR: III **PART: II**

SN	Course Code	Course Title	Teaching Scheme						Evaluation Scheme						Total Marks	Remark
			Mode				Total Hour	Credit Hours	DISTRIBUTION OF MARKS							
									Theory			Practical				
			L	T	P	Lab			*Assmt Marks	Final Marks	Exam Hours	*Assmt Marks	Final Marks	Exam Hours		
1	EG 3201 RAE	Estimating and Costing	3	1			4	3	20	80	3				100	*Continuous assessment
2	EG 3202 RAE	Heating, Ventilation and Air Conditioning III	3	1	3		7	5	20	80	3	60	40	4	200	
3	EG 3201 MG	Entrepreneurship Development	3		2		5	4	20	60	3	10	10	2	100	
4	EG 3203 ME	Occupational Hygiene and Safety	3				3	3	20	80	3				100	
5	EG 3203 RAE	Building Services	4			4	8	6	20	80	3	50			150	
6	EG 3204 RAE	Project			7		7	4				120	80	6	200	
7		Elective : (One of the following)	3			3	6	5	20	80	3	50			150	
	EG 3205 RAE.1	a. Automobile Air Conditioning														
	EG 3205 RAE.2	b. Transport Refrigeration and Air Conditioning														
	EG 3205 RAE.3	c. Refrigerant Management														

	EG 3205 RAE.4	d. Energy Audit and Management														
		TOTAL	**19**	**2**	**12**	**7**	**40**	**30**							**1000**	

L = Lecture, T = Tutorial, P = Practical

First Year (First and Second Semester)

[See Separate Curriculum]
First Year Engineering All
(Year I Part I and Year I Part II)

Second Year
Part I & II
(Third and Fourth Semesters)

1.

Third Semester
Year II Part I

Subjects:

1. EG 2102 ME Electrical Technology
2. EG 2101 ME Basic Electronics Engineering
3. EG 2105 ME Thermal Engineering
4. EG 2101 RAE Workshop Practice II
5. EG 2102 RAE Refrigeration-I
6. EG 2103 RAE Electrical Installation

Electrical Technology

EG 2102 ME

Total: 5 Hrs/week
Year: II **Lecture: 3 Hrs/week**
Part: I **Tutorial: Hrs/week**
Practical: Hrs/week
Lab: 2 Hrs/week

Course Description:

This course provides a basic framework for understanding the fundamental concept of electric circuits. The course deals with circuit fundamentals and electric machines.

Course Objectives:

After completing this course the students will be able to:
1. Understand the fundamental concept of electric circuits
2. Understand the fundamental principles of AC and DC systems
3. Understand the DC and AC machines.

Course contents:

Unit 1: Introduction [4 Hrs]

1.1 Electric sources: Current and Voltage Source, AC and DC sources
1.2 Concept of electric charge and current flows in a circuit
1.3 Emf and potential differences
1.4 Concept of generation, transmission and distribution system of electricity in Nepal
1.5 Concept of resistance, inductance and capacitance
1.6 Resistance, resistivity, temperature coefficient of resistance, variation of resistance with temperature
1.7 Series and parallel combination of resistors, inductors and capacitors

Unit 2: Electric Circuit and Theorem [7 Hrs]

2.1 Electric circuit, series and parallel circuit
2.2 Ohm's law, its application and limitations
2.3 Electrical Power & Energy
2.4 Kirchhoff's Law and their application using mesh analysis and nodal analysis method
2.5 Ideal and practical sources
2.6 Condition for maximum power transfer

Unit 3: AC circuit Analysis [9 Hrs]

3.1 Generation of 1-phase AC voltage and current
3.2 Waveform and terms used in AC: Cycle, frequency, time period, amplitude, phase and phase difference
3.3 Average and r.m.s, peak and peak-to-peak value of current and voltage
3.4 AC in pure resistance, inductance and capacitance (equation and waveform of current, voltage and average power)

3.5 AC in RL, RC and RLC series circuit (equation and waveform of current and voltage; analysis of power and power factor)
3.6 Types of power in AC, power factor, its practical importance and power factor improvement
3.7 Measurement of power in single phase AC circuit
3.8 Basic concept and advantages of 3-phase system, phase and line quantities

Unit 4: Lighting Devices, Wiring System, Electrical Safety and Protection [3 Hrs]

4.1 Different types of lighting system: Incandescent, Tungsten- halogen, Compact florescent, Tubular Florescent and LED lamp
4.2 Types of wiring: Open wiring vs Conceal wiring
4.3 Grounding, Earthing and its importance, system grounding vs equipment grounding
4.4 Definition and function of protection devices: Fuse, MCB, Lightning arrestor
4.5 Electric shock, preventive method and first aid to be taken in electrical accident

Unit 5: Transformer [3 Hrs]

5.1 Transformer: construction and working principle
5.2 Emf equation of transformer
5.3 Voltage and current transformation ratio of transformer
5.4 Basic concept on losses and efficiency of transformer

Unit 6: DC Machines [7 Hrs]

6.1 DC Generators: operating principle of dc generator, method of excitation, armature reaction
6.2 DC Motor: Operating principle of dc motor, back emf in dc motor, types of dc motor
6.3 Speed and direction control of DC motor

Unit 7: AC Machines [9 Hrs]

7.1 Construction of AC machine
7.2 Synchronous Machine:
  7.2.1 Synchronous Generator: Construction and operating principle, application and advantages and disadvantages.
  7.2.2 Synchronous Motor: Synchronous speed, construction and operating principle, application and advantages and disadvantages.
7.3 Induction motor: Introduction and construction, operating principle, application, advantages and dis-advantages.

Unit 8: Selection of Motor [3 Hrs]

8.1 Relationship between force, torque, rpm and power of motors
8.2 Sizing and selection of motors
8.3 Practical applications with examples.

Practical/Laboratory: ***[30 Hrs]***

1. Use of ammeter and voltmeter to measure current and voltage [3 Hrs]
2. Verification of ohm's law. [3 Hrs]
3. Verification of KCL and KVL. [3 Hrs]
4. Measurement of AC circuit parameters using RLC series circuit. [6 Hrs]
5. Voltage, current and power measurements in 1-Ǿ and 3-Ǿ system [3 Hrs]
6. Measurement of power factor of ac loads [3 Hrs]
7. Demonstration of various parts of AC and DC machine. [3 Hrs]
8. Basic design and selection of motors for practical applications [6 Hrs]

References:

1. B. L. Thareja & A.K. Thareja, "A text book of electrical technology Volume I and II", S. Chand and Company, India
2. S.K.Sahdev, "Fundamentals of Electrical Engineering & Electronics", Dhanapati Rai & Company, India.
3. J.B. Gupta, "Fundamentals of Electrical Engineering and Electronics", S.K. Kataria & Sons.

Mark Specification for Final Examination:

Unit	Content	Course Hours	Marks
1	Introduction	4	8
2	Electric Circuit and Theorem	7	12
3	AC circuit Analysis	9	20
4	Lighting Devices, Wiring System, Electrical Safety and Protection	3	4
5	Transformer	3	4
6	DC Machines	7	12
7	AC Machines	9	16
8	Selection of Motor	3	4
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks.

Basic Electronics Engineering

EG 2101 ME

Total: 5 Hrs/week
Year: II **Lecture: 3 Hrs/week**
Part: I **Tutorial: Hrs/week**
Practical: Hrs/week
Lab: 2 Hrs/week

Course Description:

This course deals with various types of electronic devices and circuits required for the diploma in mechanical/automobile/refrigeration engineering.

Course Objectives:

After completing this course the student will be able to:

1. Identify and explain the working principles of various semiconductor devices, relate their characteristics and applications.
2. Explain the characteristics of CB, CE and CC configuration circuits.
3. Identify and explain the working of digital electronics.

Course contents:

Unit 1: Introduction [2 Hrs]

1.1 Status of electronics in Nepal
1.2 Basic electronics components and their application in the field of mechanical and automobile engineering

Unit 2: Semiconductor Diode and Applications [9 Hrs]

2.1 Basic concept of semiconductors, intrinsic and extrinsic semiconductor
2.2 Types of semiconductor (N type and P type)
2.3 Introduction to PN junction diode: Basic structure, biasing, VI characteristics
2.4 Application of diode: Half and full wave rectifier circuit and their operation with RC filter
2.5 Zener diode: Basic construction, principle of operation, VI characteristics, Zener diode as voltage regulator
2.6 Introduction of LED, Photodiode, Varacters diode, Tunnel diodes

Unit 3: Introduction to Bipolar Junction Transistor (BJT) [8 Hrs]

3.1 Basic structure of BJT, principle of PNP and NPN configuration
3.2 Concept of BJT biasing, load line and Q-point, general characteristics of BJT
3.3 BJT as an amplifier and switch
3.4 Basic configuration of transistor circuits (CE, CB, CC), VI characteristics of CE, CB, CC and their comparison

Unit 4: Introduction to Special Semiconductor Devices [4 Hrs]

4.1 Basic construction, features, and uses of:

4.1.1 Silicon controlled rectifier
4.1.2 UJT (unijunction transistor)
4.1.3 JFET (junction field effect transistor)

4.1.4 Silicon controlled rectifier
4.1.5 UJT (unijunction transistor)
4.1.6 JFET (junction field effect transistor)
4.1.7 MOSFET (metal oxide semiconductor)
4.1.8 Photo diode and optocoupler

Unit 5: Introduction to Integrated Circuit [2 Hrs]

5.1 Introduction
5.2 Schematic symbol
5.3 Introduction to SSI, LSI, VLSI

Unit 6: Fundamentals of Digital Electronics [10 Hrs]

6.1 Number systems: Decimal, Binary, Octal and Hexa- decimal, conversion of number system
6.2 Binary arithmetic: Addition, subtraction, multiplication and division of binay numbers
6.3 Logic gates: Symbols, truth table, Boolean expression of OR, NOT, NOR, AND, NAND, XOR and XNOR
6.4 Boolean algebra and associate rules
6.5 De-Morgan's theorem (statement only)
6.6 Introduction to universal gate

Unit 7: Introduction to Combinational Logic Devices [5 Hrs]

7.1 Encoder/decoder
7.2 Multiplexer and de-multiplexer
7.3 Adder and sub-tractor

Unit 8: Introduction to Sequential Logic Devices [5 Hrs]

8.1 Introduction to latches and flip flops
8.2 Basic construction, symbol and truth table of SR, JK, D, T flip flop
8.3 Introduction to counters: Synchronous and asynchronous counters (ring counter)
8.4 Shift registers: shift left and shift right

Practical/ Laboratory: ***[30 Hrs]***

1. Study of VI characteristics of PN junction diode [3 Hrs]
2. Design and study of rectifier circuits [3 Hrs]
3. Study of VI characteristics of CE, CB and CC configuration of transistor [6 Hrs]
4. Study of logic gates using trainer kits [6 Hrs]
5. Study of encoder and decoder [3 Hrs]
6. Study of multiplexer and de- multiplexer [3 Hrs]
7. Study of adder and sub-tractor [3 Hrs]
8. Study of counter and register [3 Hrs]

References:

1. T.F. Bogard, "Electronics device and circuit", Pearson Publication
2. M. Morris Mano, "Digital Logic and Computer Design",Pearson Publication
3. J.B Gupta, "Electronics devices and circuits", S.K. Kataria and Sons
4. V.K Mehta, "Principle of electronics", S. Chand and Company.
5. Malvino Brown, "Fundamentals of digital electronics" Tata McGraw-Hill.

Mark Specification for Final Examination:

Unit	Content	Course Hours	Marks
1	Introduction	2	4
2	Semiconductor Diode and Applications	9	16
3	Introduction to Bipolar Junction Transistor (BJT)	8	16
4	Introduction to Special Semiconductor Devices	4	8
5	Introduction to Integrated Circuit	2	4
6	Fundamentals of Digital Electronics	10	16
7	Introduction to Combinational Logic Devices	5	8
8	Introduction to Sequential Logic Devices	5	8
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks.

Thermal Engineering

EG 2105 ME

Year: II **Total: 5 Hrs/week**
Part: I **Lecture: 3 Hrs/week**
Tutorial: 1 Hrs/week
Practical: Hrs/week
Lab: 2/2 Hrs/week

Course Description:

This course deals with the fundamental laws of thermodynamics, basic thermodynamics processes, introduction to heat transfer, types and uses of air compressors and boilers.

Course Objectives:

After completing this course the student will be able to explain:

1. Laws of thermodynamics
2. Basic thermodynamics processes
3. Heat transfer
4. The uses and operation of boilers and air compressors

Course content

Unit 1: Basic Concept of Thermodynamics: **[6 hrs]**

- 1.1 Definition and importance of thermodynamics
- 1.2 Thermodynamic system (closed, open and isolated system)
- 1.3 Properties of system (intensive and extensive properties)
- 1.4 Thermal equilibrium
- 1.5 Thermodynamic state
- 1.6 Thermodynamic process, cycle
- 1.7 Forms of energy
- 1.8 Sensible heat and latent heat

Unit 2: Zeroth Law of Thermodynamics: **[2 hrs]**

- 1.1 Definition and applications
- 1.2 Different types of thermometer and their applications.

Unit 3: First Law of Thermodynamics: **[7 hrs]**

- 3.1. Statement of first law, mathematical representation
- 3.2. Application of first law; closed system only
- 3.3. General energy equation, internal energy, enthalpy, relationship between heat transfer and change in internal energy

Unit 4: Second Law of Thermodynamics: **[7 hrs]**

- 4.1. Limitation of first law

4.2. Statements of second law: Kelvin Planck and Clausius statement
4.3. Concept of Carnot cycle, heat engine, heat pump and refrigerator; thermal efficiency and COP
4.4. Reversible and irreversible processes, entropy, T-S diagram

Unit 5: Basic Thermodynamic Processes: [5 hrs]

5.1. Constant volume process
5.2. Constant pressure process
5.3. Constant temperature process
5.4. Adiabatic process
5.5. Polytropic processes

Unit 6: Heat Transfer: [6 hrs]

6.1. Modes of heat transfer (conduction, convection and radiation)
6.2. Fourier's law of heat conduction (Temperature gradient, Thermal conductivity)
6.3. Newton's law of heat transfers by convection, free and forced convection
6.4. Heat transfer by radiation, Stefan- Boltzmann law of thermal radiation

Unit 7: Air Compressors: [4 hrs]

6.1 Classifications of Air compressors
6.2 Uses of compressed air
6.3 Single stage reciprocating compressors: construction, operation and care
6.4 Centrifugal compressors: construction, operation and care

Unit 8: Boilers [8 hrs]

8.1. Introduction and applications
8.2. Classifications and comparison between water tube and fire tube types of boilers
8.3. Requirements of an ideal boiler
8.4. Boiler mountings and accessories: water level indicator, feed check valve, Blow off cock, steam separator, safety valves, Feed pump, air preheater, super heater and economizer
8.5. Water conditioning
    8.5.1 Water problems and Benefits of water conditioning
    8.5.2 Constituents and Characteristics of water
    8.5.3 Types and causes of scale and deposits
    8.5.4 Scale deposit prevention methods

Tutorials: ***[15 hrs]***

Assist students for conceptual & critical problem solving

1. Problems related to properties of system [2 hrs]
2. Problems related to energy conservation equation for closed system [4 hrs]
3. Problems on heat engine, heat pump and refrigerator [3 hrs]
4. Problems related to different thermodynamic processes [3 hrs]
5. Problems on conduction, convection and radiation [3 hrs]

Practical (Laboratory): ***[15 hrs]***

1) Determine thermal conductivity of given specimen.
2) Compare different types of thermometers.
3) Demonstrate steam tables & charts
4) Study performance of air-compressor
5) Conduct a visit to local food processing industry/hotel to study the operation and performance of boiler

Suggestion for instruction:

1. Use illustrative teaching materials like model, charts and video to visualize the complex parts.

References:

1. M. C. Luintel, “Fundamentals of Thermodynamics and Heat Transfer”, Heritage Publishers & Distributors Pvt. Ltd., Nepal
2. RS Khurmi and JK Jupta, "A text book of Thermal Engineering", S. Chand Publishing, India
3. R.K. Rajput, “Thermal engineering” Laxmi Publications, New Delhi.

Marks Specification for final examination:

Unit	Content	Course Hours	Marks
1	Basic Concept of Thermodynamics	6	11
2	Zeroth Law of Thermodynamics	2	4
3	First Law of Thermodynamics	7	12
4	Second Law of Thermodynamics	7	12
5	Basic Thermodynamic Processes	5	9
6	Heat Transfer	6	11
7	Air Compressors	4	7
8	Boilers	8	14
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks.

Workshop Practice II
EG 2101 RAE

Total: 11 Hrs/week
Year: II **Lecture: 3 Hrs/week**
Part: I **Tutorial: Hrs/week**
Practical: 8 Hrs/week
Lab: Hrs/week

Course description:

This course is the extension one for the students who have undergone Workshop Practice-I. This course provides a basic knowledge about mechanical measurement along with sheet metal, plumbing, arc and gas welding operation which are essential in the field of Refrigeration and Air conditioning. It also gives brief concept of basic machine tools used in mechanical workshop.

Course Objectives:

After completion of this course student will be able to:

1. Identify and perform measurement using different measuring instrument.
2. Perform basic sheet metal works
3. Understand and perform plumbing work
4. Explain and perform different welding techniques.
5. Explain various operation in different machine tools used in workshop

Course Content:

Unit 1: Mechanical Workshop **[2 Hrs]**

1.1 Introduction
1.2 Scope and application
1.3 Introduction to Safety: Personal, Machine, Work and General

Unit 2: Metrology and Measurement **[6 Hrs]**

2.1 Introduction, Units, Dimensions and Standards
2.2 Types and Scope of Metrology
2.3 Metrological terminology (Accuracy, Precision, Repeatability, Reproducibility, Sensitivity, Resolution, Calibration, Magnification, Backlash, Range, Span, Traceability, Drift, Response, Stability)
2.4 Errors (types and sources of errors)

Unit 3: Measuring Instruments and Gauges **[8 Hrs]**

3.1 Mechanical measurement and its type: linear, angular and surface measurement
3.2 Standard in Mechanical Measurement: Line and End Standard
3.3 Construction, working principle, type of Vernier caliper and Micrometer.
3.4 Linear measuring instrument basic concept: steel rule, calipers, divider, telescopic gauge, depth gauge, screw pitch gauge, radius and feeler gauge, slip gauges or gauge blocks, comparator, dial indicator.

3.5 Angular Measuring Instrument (basic concept): engineering square, combination set, protractor, adjustable bevel, spirit level

Unit 4: Sheet Metal Works [3 Hrs]

4.1 Introduction

4.2 Tools and equipment (Hammers, Stakes, Mandrels, Shears, Groovers etc.)

4.3 Heming, Seaming, Edge preparation, Stamping, Embossing and other forming

Unit 5: Plumbing Works [3 Hrs]

5.1 Introduction

5.2 Plumbing tools: types, materials, use and care.

5.3 Pipes types: polythene, GI, CI

5.4 Operations (bending, thread cutting, joining)

5.5 Pipe fittings: types and uses

Unit 6: Welding [7 Hrs]

6.1 Introduction, classification and selection of different types of welding process

6.2 Arc Welding:

6.2.1 Introduction

6.2.2 Arc Welding equipment and accessories

6.2.3 Welding joints: types and application

6.2.4 Defects on welding process, cause and their possible remedies

Unit 7: Gas Welding and Gas Cutting [8 Hrs]

7.1 Introduction to oxyacetylene (Gas) welding: Principle, application, advantages and safety

7.2 Oxyacetylene welding equipment and accessories

7.3 Oxy-acetylene flame: types, properties and use

7.4 Welding joints, welding position and types of welds

7.5 Brazing

- Brazing principle, application and advantages
- Difference between welding and brazing
- Brazing equipment and materials
- Brazing procedures

7.6 Distortion in welding: types and their control

7.7 Testing of welding joints: types and process

7.8 Gas Cutting: Introduction, Principle, methods and influencing factors

Unit 8: Introduction to Machine Tools [8 Hrs]

8.1 **Lathe:** Introduction, Parts, Operations and Applications

8.2 **Milling Machine**: Introduction, Parts, Operations and Applications

8.3 **Drilling Machine:** Introduction, Parts, Operations and Applications

8.4 **Shaper Machine:** Introduction, Parts, Operations and Applications

Practical/ Laboratory: ***[120 Hrs]***

1. **Measurement Practice:** **[12 Hrs]**
   - Perform measurement using different types of Vernier caliper and Micrometer Screw gauge.
   - Perform angular measurement using engineering square, combination set, protractor, adjustable bevel, spirit level
   - Familiarization with various measuring instrument steel rule, calipers, divider, telescopic gauge, depth gauge, screw pitch gauge, radius and feeler gauge, slip gauges or gauge blocks, comparator, dial indicator Surface plate, surface gauge, Straight Edge
2. **Sheet Metal Practice** **[20 Hrs]**
   - Sheet metal working: Hands pipe bend plot, blow horn, groove and seaming
   - Sheet Developing: Patterns, templates, for the sheet boxes, book stand, scoop funnel, pipe, duct and machine guards
3. **Plumbing Practice :** **[16 Hrs]**
   - Practice on Pipe Bending, Thread Cutting, Flaring, Swaging, etc.
4. **Arc Welding Practice** **[16 Hrs]**
   - Padding on flat surface, Closed and Square butt joint, Corner joint, Tee joint, Lap joint, V-butt joints
5. **Gas Welding Practice** **[16 Hrs]**
   - Lining with and without filler rod, Butt joint, Corner joint, Lap joint and Straight gas cutting
6. **Brazing Practice** **[20 Hrs]**
   - Closed square butt joint brazing, Lap joint brazing, Tee joint brazing, Circular Brazing
7. **Practice on Machine Tools** **[20 Hrs]**
   - Practice on lathe: Facing, Step Turning and Tapper Turning
   - Practice on Milling: Simple milling operation
   - Practice on drilling: Simple drilling operation
   - Practice on Shaper machine: Simple work on shaper machine

References:

1. S. K. Hajra Choudhury, S.K. Bose and A. K. Hajra Choudhury, "Elements of Workshop Technology Vol. I", Media Promoters and Publishers Pvt Ltd, Bombay, India
2. R. S. Khurmi and J. K. Gupta, "A text book of Workshop Technology", S. Chand and Company Ltd, New Delhi, India
3. B. S. Nagendra Parashar and R. K. Mittal, "Elements of Manufacturing Processes", Prentice Hall of India Pvt Ltd, New Delhi, India
4. R. K. Jain, "Engineering Metrology", Khanna Publishers.
5. J. F. W. Gayler and C. R. Shotbolt, "Metrology for Engineers" Cassell, London. SI Edition.
6. M. Mahajan, "A Text book of Metrology", Dhanapat Rai & Co. (P) Ltd., Delhi,

Marks specification for Final Examination:

Unit	Content	Course Hours	Marks

1	Mechanical Workshop	2	4
2	Metrology and Measurement	6	10
3	Measuring Instruments and Gauges	8	14
4	Sheet Metal Works	3	6
5	Plumbing Works	3	6
6	Welding	7	12
7	Gas Welding and Gas Cutting	8	14
8	Introduction to Machine Tools	8	14
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks.

Refrigeration– I
EG 2102 RAE

Total: 8 Hrs/week
Year: II **Lecture: 3 Hrs/week**
Part: I **Tutorial: 1 Hrs/week**
Practical: 4 Hrs/week
Lab: Hrs/week

Course Description:
This course has been designed to introduce students with refrigeration. This course will help the students to develop basic concepts about refrigeration, its systems, identify basic components of the systems and their uses.

Course Objectives:
After completion of this course, the students will be able to

1. Explain refrigeration process,
2. Handle basic refrigeration tools
3. Use basic measuring instruments in refrigeration
4. Identify various components of refrigeration system
5. Complete the wiring of simple domestic refrigerators
6. Charge the refrigerant in a domestic refrigerator.

Course Contents:

Unit 1: Basic Concepts **[10 Hrs]**

1.1 History of Refrigeration
1.2 Units of Refrigeration
1.3 Types of Refrigeration
   a. Ice Refrigeration
   b. Air Refrigeration
   c. Thermo-electric Refrigeration
   d. Evaporative Refrigeration
   e. Vapor Compression Refrigeration
   f. Absorption Refrigeration
   g. Liquid Nitrogen Refrigeration

Unit 2: Components of Vapor Compression Refrigeration Systems: Construction, Types, and Functions **[10 Hrs]**

2.1 Compressor
2.2 Condenser
2.3 Evaporator
2.4 Liquid receiver
2.5 Accumulator
2.6 Sight glass
2.7 Oil separator
2.8 Filter drier
2.9 Vibration eliminator

2.10 Service valve
2.11 Check Valve
2.12 Pressure Relief valve (PRV)
2.13 Solenoid valve
2.14 Four way reversing valve

Unit 3: Types, Construction and Operation of Flow Control Devices [8 Hrs]

3.1 Capillary Tube
3.2 Hand Expansion Valve
3.3 Automatic Expansion Valve (AEV)
3.4 Thermostatic Expansion Valve (TEV/TXV)
3.5 Thermal-electric Expansion Valve
3.6 Electronic expansion valve
3.7 High-side Float
3.8 Low-side Float

Unit 4: Refrigerants [6 Hrs]

4.1 Classification
4.2 Identification of Refrigerants by numbers
4.3 Properties of an ideal refrigerant
4.4 Properties and pressure-temperature charts of various refrigerants (CFC, HCFC, HFC, HFO, Hydro carbon and Natural gases)
4.5 Ozone depletion, global warming potential issues and alternate refrigerants

Unit 5: Lubrication [4 Hrs]

5.1 Definition of lubrication
5.2 Properties of Lubricant
5.3 Types of lubricant (Natural and Synthetic poly oil)
5.4 Methods of lubrication

Unit 6: Domestic Refrigerator [7 Hrs]

6.1 Refrigeration piping for Single Door/Double Door Refrigerator
6.2 Starting Relays
   a. Current Relay
   b. Potential Relay
   c. Hot-wire Relay
   d. PTC (Solid State) Relay
6.3 Permanent Split Capacitor
6.4 Overload Protector
6.5 Types, function and use of Thermostat
6.6 Construction and operation of frost free refrigerator
6.7 Condensate drainage system

6.8 Various systems of piping in a domestic refrigerator (Oil –cooling, door perimeter heating)

6.9 Important points for the smooth and efficient running of refrigerator

6.10 Compressor types

a. Reciprocating, rotary
b. Inverter compressor

Tutorial: ***[15 Hrs]***

1. Tutorial 1 – Basic concepts: Units of refrigeration, ice refrigeration, air refrigeration, thermo electric refrigeration. [3 Hrs]

   Tutorial 2 – Components of Vapour Compression Refrigeration System: Compressors, condensers, evaporators and different types of valves [4 Hrs]
2. Tutorial 3 – Flow control devices: Capillary tube, thermostatic expansion valve and floats [1 Hr]
3. Tutorial 4 – Refrigerants: Pressure temperature charts of various refrigerants [1 Hr]
4. Tutorial 5 – Domestic refrigerator: Refrigeration piping, relays, thermostat, reciprocating and inverter compressor, condensate drainage, operation of frost free refrigerator [6 Hrs]

Practical/ Laboratory: ***[60 Hrs]***

1. Pipes and tubes [16 Hrs]
   1.1 Distinguish between Tubes and Pipe
   1.2 Measure copper tubes using various scales
   1.3 Straitening tubes
   1.4 Cut copper tubes using various tools (Hacksaw, Tube cutter, Triangular file)
   1.5 Perform Reaming and Cleaning of tube ends
   1.6 Join copper tubes using various methods and appropriate tools and equipment
      1.6.1 Swaging
      1.6.2 Brazing
      1.6.3 Flaring
      1.6.4 Lock ring
   1.7 Bend the copper tubes using various tools (Inside/Outside Spring, Bending Tools)
2. Complete tubing projects on the basis of given measurement [8 Hrs]
3. Identify the tubing and different components of domestic refrigerator/freezer and draw the mechanical system diagram [8 Hrs]
4. Identify compressor terminals and compressor capacity [4 Hrs]
5. Trace and prepare free hand sketch of electrical circuit of domestic refrigerators [4 Hrs]
6. Complete electrical circuit of a simple domestic refrigerator using necessary components (Current / Hot-wire / PTC Relay, Door switch, Cabinet light, Over-load protector, Thermostat, Start capacitor) [8 Hrs]
7. Trace and Draw electrical circuit of a frost free refrigerator [4 Hrs]
8. Check the performance of different refrigerators [4 Hrs]
9. Charge the refrigerant in a domestic refrigerator using appropriate process and tools (Measure Pressure, Evacuation, Leak testing, charging by different methods) [4 Hrs]

References:

1. R.J. Dossat, "Principle of Refrigeration", John Wiley & Sons Ltd.
2. P.N. Ananthnarayan, "Basic Refrigeration and Air-conditioning"
3. Domkundwar, S.C. Arora, "A course in refrigeration and Air-conditioning", Dhanpat rai & Sons, India
4. R.S. Khurmi, "Textbook or refrigeration and air-conditioning", S. Chand., India

Marks specifications for final examination:

Unit	Content	Course Hours	Marks
1	Basic Concepts	10	18
2	Components of Vapor Compression Refrigeration Systems: Construction, Types, and Functions	10	18
3	Types, Construction and Operation of Flow control Devices	8	14
4	Refrigerants	6	11
5	Lubrication	4	7
6	Domestic Refrigerator	7	12
Total		**45**	**80**

Note: There might be minor deviations on the above specified marks

Electrical Installation

EG 2103 RAE

Total: 6 Hrs/week
Year: II **Lecture: 1 Hrs/week**
Part: I **Tutorial: Hrs/week**
Practical: 5 Hrs/week
Lab: Hrs/week

Course Description:

Refrigeration and Air-conditioning engineering being one of the branches of Electro-mechanical engineering, the knowledge of electrical drawing and installation is essential. The drives and control systems basically utilizes electricity and this course delivers the knowledge of Electrical Drawing and Installation.

Course Objective:

After completion of this subject, the students will be able to;

1. Identify different symbols of electrical components
2. Understand different types of protecting and control devices
3. Draw and implement layout and connection diagram of single phase system
4. Draw and implement Power and control diagram of three phase system

Course Content:

Theory: **[15 Hrs]**

Unit 1: Electrical and electronics symbols (layout and wiring) and conventions **[3 Hrs]**

Unit 2: Basic information about types of wiring and Circuit **[6 Hrs]**

2.1 Types of wiring
2.2 Factor to be considered in Wiring
2.3 Earthing and its importance in Domestic and Industrial Wiring
2.4 Basic concept of line or layout and connection wiring diagram
2.5 Basic concept of Power and control diagram in 3 phase system
2.6 Types of wire and selection criteria of wire and wire size calculation
2.7 Wiring joints: Introduction, types, selection and safety

Unit 3: Protection and Control **[6 Hrs]**

3.1 Importance and types of Protection system in Domestic and Industrial wiring
3.2 Circuit Breaker: Basic Introduction, types and selection criteria.
3.3 Switch: Basic Introduction, types and selection criteria.
3.4 Contactor and auxiliary contactor: Basic introduction and working principle

Practical/ Laboratory: ***[75 Hrs]***

Practical 1: Familiarization with electrical symbols, Tools, PPE in Domestic and Industrial wiring. **[5 Hrs]**

Practical 2: Exercise on Electrical load calculation, wire size calculation and wire selection of simple workshop with different light and power load. **[5 Hrs]**

Practical 3: Practice on different types of joints **[5 Hrs]**

Practical 4: Draw line and connection diagram of domestic wiring containing both light and power load, which contains Energy meter, MCB, One way switch, Two way and intermediate switch, bell switch, dimmer switch, light and power socket to control the respective load. **[10 Hrs]**

Practical 5: Draw and Implement control and Power diagram of DOL switch, fuses, permanently star connected three phase motor **[5 Hrs]**

Practical 6: Draw and Implement Control and power diagram using DOL starter with energizing contactor coil with high voltage as well as low voltage, indicators, over load relay, permanently delta connected 3- phase motor with load **[10 Hrs]**

Practical 7: Draw and Implement Control and Power diagram using Drum type R / F switch (manually operated) for 3-phase motor with load and fuses/MCBs **[5 Hrs]**

Practical 8: Draw and Implement control and power diagram to R / F control of 3-phase motor with contactors, over load relay, indicators and push button switches with bus bar with inter locking **[10 Hrs]**

Practical 9: Draw and Implement Control and power diagram for an electrical using push button switch, indicator lights, power contractors and Drum type star/delta switch (manually operated) 3-phase compressor motor **[10 Hrs]**

Practical 10: Draw and Implement control and power diagram for star/delta control of 3-phase compressor motor with contactors, over load relay, indicators, timer motor and push button switches with bus bar **[10 Hrs]**

References:

1. Surjit Singh, "General Electrical Drawing, Part I and II", S.K. Kataria and Sons, India
2. J.B. Gupta,"A Course in Electrical Engineering", S.K. Kataria and Sons.
3. Stephen L. Herman, "Electrical Wiring Industrial", Cengage Learning

Mark Specification for Final Examination:

Examination	Content	Marks
Internal (100 marks)	Attendance and job performance	50
	Lab/Practical Report	20
	Practical exam	30
Final (50 marks)	Viva voce	20
	Practical exam	30
Total		**150**

Fourth Semester

Year II Part II

Subjects:

1. EG 2201 RAE Instrumentation and Control
2. EG 2202 RAE Applied Electronics
3. EG 2203 RAE Refrigeration-II
4. EG 2204 RAE Heating, Ventilation & Air-Conditioning
5. EG 2206 ME Fluid Mechanics and Fluid Machines
6. EG 2205 RAE Mechanics of Materials
7. EG 2206 RAE Machine Drawing

Instrumentation and Control System

EG 2201 RAE

Total: 5 Hrs/week

Year: II **Lecture: 3 Hrs/week**

Part: II **Tutorial: Hrs/week**

Practical: Hrs/week

Lab: 2 Hrs/week

Course description:

This course deals with the fundamentals of Instrumentation, measurements and control. Students will understand and basic principles of various measuring instruments.

Course objectives:

After the completion of this course, students will be able to:

1. Understand the importance of measurement and units
2. Understand the working of electrical measurement instruments
3. Understand the working of different types of transducers
4. Understand the basic concept of control system and its applications

Course Contents

Unit 1: Introduction **[4 Hrs]**

1.1. Scope and necessity of instrumentation

1.2. Basic components of instrumentation system

1.3. Introduction to measurement, measurement terms and measurement system

1.4. System of international units (SI) & symbols

1.5. Electrical instruments: Types, Schematic symbols, Basic characteristics and Application

Unit 2: Electrical Measurements **[12 Hrs]**

2.1 Ammeters & Voltmeters

2.1.1 Basic construction, operating principle and applications of: Moving iron and moving coil instruments, Permanent Magnet moving coil (PMMC Instruments), Dynamometer type instruments and Induction type instruments

2.2 Measurements of Resistance

2.2.1 Classification

2.2.2 Measurement of low, medium and high resistance

2.2.3 Basic construction, operating principle and applications of: Ohm Meters, AVO meter and Megger

2.3 Measurement of Power

2.3.1 Measurement of power using voltmeter & ammeter

2.3.2 Wattmeter type:

- Energy meter (kWh meter), Operation & application
- Dynamo type meter, Operation & application

2.3.3 Instrumental Transformer:

- Introduction to potential transformer, operation and application
- Introduction to current transformer, operation and application

Unit 3: Transducers **[10 Hrs]**

3.1 Introduction and classification of Transducer

3.2 Resistive Transducer: Potentiometer, Strain Gauge and Resistor Temperature Dependent (RTD) - working and their applications

3.3 Inductive Transducer: Linear Variable Differential Transformer (LVDT)- working and its applications

3.4 Capacitive Transducer: By varying overlapping area, distance and permittivity of dielectric between plates- working and applications

3.5 Piezoelectric and Hall Effect Transducers- working and applications

3.6 Thermistors and Thermocouples-working and applications

Unit 4: Application of Instrumentation **[9 Hrs]**

4.1 Selection of Instruments:

4.1.1 Factors effecting instrument selection, accuracy, precision, linearity, resolution, sensitivity, hysteresis, reliability, serviceability, loading effect, range advantage and limitation, cost effectiveness and availability

4.1.2 Static and dynamic response

4.1.3 Environmental effect

4.1.4 Calibration tool

4.2 Mechanical Measurement: working principle and basic diagram of force & torque, pressure and flow measurement using transducer

4.3 Miscellaneous measurement: level, pH, gas analyzer, emissivity, refractive index, viscosity, surface tension, Spectro-photo-metry, chromatography & NIR, Introduction to biosensors.

Unit 5: Introduction to Control System **[6 Hrs]**

5.1 Functional block diagram of a Basic control system

5.2 Open loop and Closed Loop Control System with examples

5.3 Types of control system: Cascade, Ratio, Feed-forward and Split range

5.4 Effect of Feedback on System gain, stability, noise and sensitivity

5.5 Basic concept of Proportional (P), Derivative (D), Integral (I) and PID controller

5.6 Practical applications of control system to control position, velocity, temperature

Unit 6: Motors in Control Systems **[4 Hrs]**

6.1 Servo mechanism: DC Closed loop control system and AC closed loop control system

6.2 Working of stepper motors and their driver circuits for control system

6.3 Inverter motor control for VRF/VRV air conditioning system

Practical/ Laboratory: ***[30 Hrs]***

1. Measurement of Voltage, Current using Ammeters & Voltmeters [2 Hrs]
2. Measurement of Resistance using Ohm Meters, AVO meter or Megger [2 Hrs]
3. Measurement of power and power factor of AC motor using Wattmeter [4 Hrs]
4. Sensitivity calculation of any one of resistive transducer [2 Hrs]
5. Sensitivity calculation of capacitive transducer [2 Hrs]
6. Sensitivity calculation of LVDT [2 Hrs]
7. Test the performance of open loop and closed loop control system with suitable example [4 Hrs]

8. Test the performance of servo mechanism [4 Hrs]
9. Measurement of flow in a pipe using transducer. [4 Hrs]
10. Demonstration of Inverter motor control for VRF/VRV air conditioning system [2 Hrs]

References:

1. J.B. Gupta "A Course in Electronics & Electrical Measurement & Instrument"
2. A.K. Sawhney "A Course in Electrical & Electronics measurement & instrumentation", Dhanpati Rai & Co. (Pvt.) Ltd
3. R.K. Jain, "Mechanical and Industrial Measurement", Khanna Publishers, New Delhi
4. M.F. Kureshi, " Advanced Instrumentation and Control"
5. G.T. Brayan, "Control system for technicians", Hodder and Stoughton Educational, Great Britain
6. A.K. Mahalanabis, "Introductory System Engineering" Wiley eastern Limited, India
7. L.A Meyer, "Control System Basics for HVAC Technicians" Lama Books, ISBN: *41-0-88069-036-2*
8. G.T. Brayan, "Control system for technicians", Hodder and Stoughton Educational, Great Britain
9. A.K. Mahalanabis, "Introductory System Engineering" Wiley eastern Limited, India,

Mark Specification for Final Examination:

Unit		Course Hours	Marks
1	Introduction	4	8
2	Electrical Measurements	12	20
3	Transducers	10	18
4	Application of Instrumentation	9	16
5	Introduction to Control System	6	10
6	Motors in Control Systems	4	8
	Total	**45**	**80**

Note: There might be minor deviation on the above-specified marks.

Applied Electronics
EG 2202 RAE

Year: II **Total: 6 Hrs/week**
Part: II **Lecture: 4 Hrs/week**
Tutorial: Hrs/week
Practical: Hrs/week
Lab: 2 Hrs/week

Course Description:

This subject is the continuation of Electronic Fundamental that is included in Diploma in Refrigeration II Year I Part with emphasize on data conversion, instrumentation and power circuits. To meet the industry, need, diploma holder must know about the most fundamental subjects like electronic devices and circuits. By studying this subject, they will be skilled in handling all types of electronic devices and able to apply the skill in electronics system.

Course Objectives:

On completion of this course, the student will be able to

1. Introduce the fundamentals of analysis of electronic circuits
2. Provide the basic understanding of semiconductor devices and analog integrated circuits
3. Understand the principle power electronics and DC power supply

Course content:

Unit 1: Operational Amplifier **[10 Hrs]**

1.1 Ideal characteristics of Op-amp
1.2 Practical Op-amp and its applications
1.3 Inverting and Non–inverting configuration of Op-Amp
1.4 Op-amp as Adder, differentiator, integrator, comparator, buffer
1.5 Instrumentation Amplifier: Single op-amp
1.6 Feedback: Definition, Types and their applications
1.7 Introduction to Oscillator and its applications

Unit 2: Multi-Vibrators **[6 Hrs]**

2.1 Introduction of Astable, Mono-stable and Bi-stable Multi-vibrator
2.2 Transistor based Astable multi-vibrator
2.3 Generation of square and triangular waveform using Astable multi-vibrator
2.4 IC 555 based Multi-vibrators

Unit 3: Analog to Digital and Digital to Analog Converter **[10 Hrs]**

3.1 Introduction to D/A Conversion and applications
3.2 Introduction to A/D Conversion: Sampling theorem, Sample and Hold Circuit
3.3 Types of D/A converter: Binary Weighted Resistor, R-2R Ladder Network DAC
3.4 Types of A/D converter: Flash and Successive Approximation ADC
3.5 Basic Characteristics of A/D and D/A Converters

Unit 4: Electronic Filter **[4 Hrs]**

4.1 Function and importance of filter in electrical and electronic applications
4.2 Passive and Active filter
4.3 Basic circuit diagram, operation and applications of passive filter circuits: High pass, Low pass, Band pass and Band stop

Unit 5: Memory Devices **[4 Hrs]**

5.1 Volatile and Non-Volatile Memories
5.2 Read Only Memory (ROM)
5.3 Introduction to ROM Family: Mask ROM, PROM, EPROM, EEPROM
5.4 Random Access Memory (RAM)
5.5 RAM Family

Unit 6: Introduction to Power Electronics and Optoelectronics **[16 Hrs]**

6.1 Introduction and applications of power electronics
6.2 Introduction to power semi-conductor devices: Power diodes, Thyristors and Power Transistors and their applications
6.3 Power electronics circuits:
- 6.3.1 Construction, working and application of Diode rectifiers- Half wave and full wave
- 6.3.2 Construction, working and application of DC-DC converters (Buck Converter and Boost Converter)
- 6.3.3 Construction, working and application of DC-AC converters (PWM inverters)
- 6.3.4 Diac and Triac: Characteristics and applications
- 6.3.5 Principle and application of controller rectifiers
- 6.3.6 Principle and application of AC-AC converter (Ac voltage controllers)

6.4 Photo Transistor: Characteristics and applications
6.5 Opto-Coupler: principle and applications
6.6 Solar cell, LDR: principle and application

Unit 7: Power Supplies and Voltage Regulators **[10 Hrs]**

7.1 Power Supplies: Unregulated Power Supply and Regulated Power Supply
7.2 Linear Voltage Regulator: Zener Voltage Regulator; Transistor series regulator
7.3 Protection of power supplies against overload and short circuit: basic circuit, working principle
7.4 Integrated circuit voltage regulator: Fixed (eg. IC 78XX and 79XX series) and variable (eg. LM 317)
7.5 Introduction to Switched Mode Power Supply (SMPS) and UPS
7.6 Control circuit (PWM) in SMPS
7.7 Introduction to variable frequency drive for motor control

Practical/Laboratory: ***[30 Hrs]***

1. Operation of Inverting and Non inverting op-amp configuration [2 Hrs]
2. Operation of Single Op-amp instrumentation amplifier [2 Hrs]
3. Observer output of R-2R ladder DAC and any one of ADC [2 Hrs]
4. Draw frequency response analysis of passive filters [2 Hrs]
5. Draw V-I characteristics of Diac and TRIAC circuit [2 Hrs]
6. Draw V-I characteristics of optocoupler and solar cell [2 Hrs]
7. Generation of square waveform using 555 time IC and BJT [2 Hrs]
8. Demonstrate switched Mode power supply [2 Hrs]
9. Refrigeration operation at low and medium voltage [2 Hrs]
10. Construction of Regulated DC power supply using full wave rectifier, Zener diode or 78xx ICS [6 Hrs]
11. Construction of a simple DC-DC converter [6 Hrs]

References:

1. NN Bhargava and kulshreshta, "Basic Electronics and Linear Circuit", Tata Mcgraw Hill, New Delhi
2. J.B. Gupta, “An Integrated Course in Electronics Engineering”, S.K Kataria & Sons
3. M.H. Rashid, "Power Electronics: Device, Circuits and Applications", Pearson Education India.
4. Robert Boylested and Louis Nashelsky, “Electronics Devices and Circuit Theory”, PHI
5. Thomas L. Floyd, “Electronics Devices”, Pearson Education Inc.
6. Theodore F Bogart, Jeffrey S. Beasley and Guillermo Rico, “Electronics Devices and Circuits”, Pearson Education, India

Marks Specification for final examination:

Unit	Content	Course Hours	Marks
1	Operational Amplifier	10	12
2	Multi-Vibrators	6	10
3	Analog to Digital and Digital to Analog Converter	10	12
4	Electronic Filter	4	6
5	Memory Devices	4	6
6	Introduction to Power Electronics and Optoelectronics	16	22
7	Power Supplies and Voltage Regulators	10	12
	Total	**60**	**80**

Note: There might be minor deviation on the above-specified marks.

Refrigeration – II

EG 2203 RAE

Total: 8 Hrs/week

Year: II **Lecture: 3 Hrs/week**

Part: II **Tutorial: 1 Hrs/week**

Practical: 4 Hrs/week

Lab: Hrs/week

Course Description:

This course has been designed to impart the knowledge regarding commercial refrigeration systems and various refrigeration devices. This course will also develop the skills for setting controlling devices as well as analyzing performance of the systems.

Course Objectives:

After completion of this course, the students will be able to

1. install and operate commercial systems
2. handle refrigerator having absorption system
3. analyze vapor compression system
4. identify various insulating materials
5. calculate heat transfer
6. handle ice manufacturing plants

Course Contents:

Unit 1: Heat Transfer **[8 Hrs]**

1.1 Modes of heat transfer

1.2 Fourier's law and conduction through slab and pipes

1.3 Conduction through composite walls and pipes.

1.4 Expression for heat transfer by convection, combined conduction and convection

1.5 Nature of thermal radiation

1.6 Stefan–Boltzmann law, Absorptivity, Reflectivity and Transmissivity

1.7 Construction and principal of operation of heat exchanger

1.8 Temperature distribution of fluids in parallel flow heat exchanger. The equation of heat transfers and the meaning of log mean temperature difference

Unit 2. Absorption Refrigeration System **[4 Hrs]**

2.1 Introduction

2.2 Principles of absorption system

2.3 Absorption system using Ammonia and Water

2.4 Absorption system using Ammonia, Water and Hydrogen (Electrolux System)

2.5 Absorption System using Lithium Bromide Solution

2.6 Vapor absorption verses vapor compression system

Unit 3: Vapor Compression System **[12 Hrs]**

3.1 Analysis of vapor compression cycle on pressure-enthalpy diagram. Wet compression, Vapor dry at suction of compressor, Vapor superheated at suction of compressor and liquid sub-cooled before throttling

3.2 Wet verses dry compression. Sources of superheating and its effects and the effects of foreign material on the performance of refrigeration cycle
3.3 Deviation of actual cycle from theoretical vapor compression cycle
3.4 Calculation of Coefficient of performance (COP) of a vapor compression Refrigeration System
3.5 Effect of Evaporator and Condenser pressure in COP.

Unit 4: Commercial Refrigeration System and Equipment [6 Hrs]

4.1 Function and working of display/storage cases/Deep-freezers (Positive/Negative temperature)
4.2 Construction and operation of
a. Low-pressure Cut-out (LPC)
b. High-pressure Cut-out (HPC)
c. Differential Pressure Cut-out
d. Oil Pressure Differential Switch
4.3 Construction and operation of Pump-down system

Unit 5: Thermal Insulation [3 Hrs]

5.1 Properties of an ideal thermal insulating material
5.2 Types of thermal Insulating Material
5.3 Critical thickness of insulation
5.4 Drawbacks of thermally insulating materials

Unit 6: Production of Low Temperature [4 Hrs]

6.1 Limitations of single stage Vapor Compression system for the production of low temperature
6.2 Compound refrigeration system
6.3 Cascade System
6.4 Application of low temperature

Unit 7: Liquefaction of Air [2 Hrs]

7.1 Joule Thompson Effect
7.2 Claude System

Unit 8: Water Coolers and Ice Making [6 Hrs]

8.1 Introduction, types, construction and working of water coolers
8.2 Introduction, types, construction and working of portable ice making machines
8.3 Principles of Ice production in a commercial scale
8.4 Different commercial system of ice manufacture

Tutorial: ***[15 Hrs]***

1. Tutorial 1 – Heat Transfer: Conduction through composite walls, combined conduction and convection, radiation, principles of heat exchanger, parallel and counter flow heat exchangers and LMTD. [4 Hrs]
2. Tutorial 2 – Absorption Refrigeration System: Working princples of ammonia-water and lithium bromide systems [1 Hr]

3. Tutorial 3 – Vapour Compression System: Pressure- enthalpy diagrams, numerical examples of wet, saturated and superheated compression and sub cooling in condenser, calculation of COP and examples showing effect of changing evaporator and condenser pressure. [5 Hrs]
4. Tutorial 4 – Thermal insulation: simple calculations of heat transfer in thermally insulation materials, critical thickness of insulation. [1 Hr]
5. Tutorial 5 – Production of low temperature: Compound refrigeration system, cascade system [2 Hrs]
6. Tutorial 6 – Theoretical calculations of water coolers and ice making [2 Hrs]

Practical/Laboratory: ***[60 Hrs]***

1. Assemble AEV, TXV and Thermo-Electric Expansion Valve in a system [8 Hrs]
2. Performance analysis of vapour compression refrigeration system with increasing/decreasing condenser and evaporator pressure, TXV settings [12 Hrs]
3. Study the performance of different deep-freezer, commercial refrigerator [8 Hrs]
4. Install LPC, HPC and trace electrical wirings. Setting cut-out and cut-in pressure in LPC, HPC, analyze power consumption [12 Hrs]
5. Install Oil Pressure differential switch, solenoid valve, thermostat and trace electrical wirings. Setting cut-out and cut-in pressure and analyze power consumption [8 Hrs]
6. Identify different types of Insulating materials [4 Hrs]
7. Study of water cooler and draw the mechanical and electrical system diagram [4 Hrs]
8. Study of inverter refrigerator [4 Hrs]

References:

1. Dossat, R.J. Principle of Refrigeration, John Wiley & Sons Ltd.
2. Ananthnarayan, P.N. Basic Refrigeration and Air-conditioning
3. Domkundwar, Arora, S.C. A course in refrigeration and Air-conditioning. Dhanpat rai & Sons
4. Khurmi R.S. Textbook or refrigeration and air-conditioning, S. Chand.
5. Rajput R.K, Chand A. Heat and mass transfer. S. Chand.

Marks specifications for final examination:

Unit	Content	Course Hours	Marks
1	Heat Transfer	8	14
2	Absorption Refrigeration System	4	7
3	Vapor Compression System	12	22
4	Commercial Refrigeration System and Equipment	6	11
5	Commercial Refrigeration System and Equipment	3	5
6	Production of Low Temperature	4	7
7	Liquefaction of Air	2	3
8	Water Coolers and Ice Making	6	11
	Total	**45**	**80**

Note: There might be minor deviations on the above specified marks.

Heating, Ventilation & Air-Conditioning I

EG 2204 RAE

Total: 7 Hrs/week
Year: II **Lecture: 3 Hrs/week**
Part: II **Tutorial: 1 Hrs/week**
Practical: 3 Hrs/week
Lab: Hrs/week

Course Description:

This course deals with the study of various properties of air, psychrometric chart and various psychrometric processes, working of main components and functions of conventional refrigeration and air-conditioning systems. It also describes the uses of and types of refrigeration and air-conditioning applications and incorporates the study of refrigerants and psychrometry.

Course Objectives:

After this course the students will be able to

1. Describe the uses of various kinds of HVAC machines
2. Explain the operation of components of conventional HVAC machines
3. Install, check and carry out servicing of HVAC components and systems

Course Contents:

Unit 1: Introduction **[3 Hrs]**

1.1 Definition and scope of Air-conditioning
1.2 History of Air-conditioning
1.3 Parameters of Air-conditioning System (Temperature, Humidity, Air quality and Air velocity)

Unit 2: Psychrometry **[12 Hrs]**

2.1 Psychrometry and psychrometric properties
2.2 Variation of psychrometric properties with altitude
2.3 Psychrometric relation: Dalton's law of partial pressure
2.4 Measurement of dry bulb temperature, wet bulb temperature and relative humidity
2.5 Psychrometric chart and its uses
2.6 Psychrometric processes: Sensible heating, sensible cooling, humidification, dehumidification, cooling with dehumidification, cooling with adiabatic humidification, heating with humidification and their representation on psychrometric chart
2.7 Mixing of two air streams

Unit 3: Air-conditioning (AC) System **[8 Hrs]**

3.1 Classification of air-conditioning system
3.2 Direct expansion (DX) air-conditioning system
3.3 All water Air-conditioning system
3.4 All air Air-conditioning system
3.5 Air Water- Air-conditioning system

Unit 4: Air Conditioning System Type **[8 Hrs]**

4.1 Window air-conditioner

4.2 Split air-conditioner and heat pumps
4.3 Package unit
4.4 Air handling units
4.5 Chiller/Boiler Systems
4.6 Variable Refrigerant Flow Systems

Unit 5: Air Distribution Systems **[10 Hrs]**

5.1 Introduction
5.2 Classification of duct
5.3 Construction of duct
5.4 Components of Air distribution system: fan, air filter, eliminator, heating coil, cooling coil, humidifier, dehumidifier, dampers, Grill, diffuser

Unit 6: Evaporative Cooling **[4 Hrs]**

6.1 Principle of operation
6.2 Construction and operation of Evaporative fan and Desert cooler

Tutorial: ***[15 Hrs]***

1. Tutorial 1 -Introduction to HVAC: Simple calculations showing effects of temperature, humidity and velocity [2 Hrs]
2. Tutorial 2 – Psychrometry: Psychrometric chart and uses, solving numericals for different psychrometric process using psychrometric chart: sensible heating, sensible cooling, humidification, dehumidification, cooling with dehumidification, cooling with adiabatic humidification, heating with humidification and their representation on psychrometric chart [6 Hrs]
3. Tutorial 3 - Air-conditioning systems types: Window air-conditioner, split air-conditioner and heat pumps, Air handling units, Chiller/Boiler Systems [4 Hrs]
4. Tutorial 4 - Air distribution system: Air distribution and duct sizing [2 Hrs]
5. Tutorial 5 - Evaporative cooling: Principle of evaporative cooling [1 hr]

Practical/Laboratory: ***[45 Hrs]***

1. Determination of psychrometric properties using psychrometer [3 Hrs]
2. Study of various psychrometric process [6 Hrs]
3. Dismantling, assembling, repair and maintenance of non-inverter type single split air-conditioning unit [9 Hrs]
4. Dismantling, assembling, repair and maintenance of inverter type single split air-conditioning unit [9 Hrs]
5. Study of VRV/VRF air-conditioning system [9 Hrs]
6. Study of ductable type air-conditioning system in various commercial and industrial sites. [9 Hrs]

References:

1. Domkundwar & Arora, "A course in Refrigeration and air conditioning", Dhanpat Rai and sons, Nai Sarak, Delhi – 110006, India
2. E. RathaKrishanan, "Fundamental of Engineering Thermodynamics", Prentice Hall India Pvt. Ltd, New Delhi – 110001, India
3. R.K. Rajput, "Refrigeration and Air-conditioning", S.K. Kataria & Sons, India
4. R. S. Khurmi, "A textbook of Refrigeration and Air-conditioning".

Marks specifications for final examination:

Unit	Content	Course Hours	Marks
1	Introduction	3	5
2	Psychrometry	12	22
3	Air-conditioning (AC) System	8	14
4	Air Conditioning System Type	8	14
5	Air Distribution Systems	10	18
6	Evaporative Cooling	4	7
	Total	**45**	**80**

Note: There might be minor deviations on the above specified marks.

Fluid Mechanics and Fluid Machines

EG 2206 ME

Total: 5 Hrs/week
Year: II **Lecture: 3 Hrs/week**
Part: II **Tutorial: 1 Hrs/week**
Practical: Hrs/week
Lab: 2/2 Hrs/week

Course Description:

This course deals with the general theories and equations of fluid mechanics with application. It also describes various applications of theories including water turbines and pumps.

Course Objectives:

After completing this course the student will be able to explain:

1. General properties of fluids
2. Various characteristics of fluid at static and kinematics conditions
3. Basic theories and equations of fluid mechanics with their applications
4. Various losses on pipe flow
5. Dynamic action of fluid
6. Basic theories and working principles of fluid machines

Course contents:

Unit: 1. Properties of Fluid **[3 Hrs]**

- 1.1 General introduction of fluid
- 1.2 Density, specific volume, specific weight and specific gravity
- 1.3 Fluid viscosity
- 1.4 Surface tension and capillarity
- 1.5 Compressibility and Bulk modulus
- 1.6 Related numerical examples

Unit 2. Fluid Static **[8 Hrs]**

- 2.1 Fluid pressure, fundamental equation of fluid static and pressure head
- 2.2 Absolute pressure, gauge pressure and atmospheric pressure
- 2.3 Pressure measuring devices
- 2.4 Simple type manometer: classification and working
- 2.5 Force on plane submerged bodies
- 2.6 Buoyancy, flotation and stability
- 2.7 Related numerical examples

Unit 3. Kinematics of Fluid **[2 Hrs]**

- 3.1 Reynold's number
- 3.2 Description of fluid motion, path line and stream line
- 3.3 Types of fluid displacement
- 3.4 General types of fluid flow

Unit 4. Basic Equations of Fluid Flow **[6 Hrs]**

4.1 Continuity equation: Statement and application on pipe flow
4.2 Bernoulli's equation: Statement and application on pipe flow
4.3 Momentum equation: Statement and application on pipe flow
4.4 Related numerical examples

Unit 5. Losses on Pipe Flow **[4 Hrs]**

5.1 Major loss: Darcey-Weisbach Equation and Moody diagram
5.2 Minor losses: contraction, expansion, bend, obstruction
5.3 Related numerical examples

Unit 6. Flow Measurement **[4 Hrs]**

6.1 Coefficients: velocity, contraction, discharge
6.2 Flow measuring devices: orifice, venturi-meter, notches
6.3 Related problems on flow over rectangular and triangular notches

Unit 7. Dynamic Action of Fluid **[4 Hrs]**

7.1 Dynamic force and power
7.2 Force exerted by fluid jet on stationary and moving flat plates
7.3 Related numerical examples

Unit 8. Water Turbines **[8 Hrs]**

8.1 Basics of hydropower plants
8.2 Introduction and development of water turbines
8.3 Classification of water turbines
8.4 Working principles of Pelton, Francis, Propeller and Cross flow turbines
8.5 Characteristics curve of turbine: Head, discharge, efficiencies, specific speed
8.6 Introduction of water turbine governor and their functions

Unit 9. Pumps **[6 Hrs]**

9.1 Classification of pumps (positive displacement and roto-dynamic pumps)
9.2 Working of centrifugal and piston pumps
9.3 Pump characteristics and selection of pump
9.4 Working principle of Hydraulic ram pump

Tutorial: ***[15 Hrs]***

1. Properties of fluid: Density, specific volume, specific weight, specific gravity, surface tension [2 Hrs]
2. Fluid Static: pressure measurement, simple manometers, force on plane submerged bodies [3 Hrs]
3. Basic equations of fluid flow: Continuity, Bernoulli's and Momentum equation for pipe flow cases [4 Hrs]
4. Losses on Pipe flow: Darcey-Weisbach Equation and Moody diagram [2 Hrs]
5. Flow measurement: rectangular and triangular notches [2 Hrs]
6. Dynamic action of fluid: Force exerted by fluid jet on stationary and moving flat plates [2 Hrs]

Practical/Laboratory: ***[15 Hrs]***

1. Study of properties of fluid [1 hr]
2. Validity of Bernoulli's theorem [3 Hrs]
3. Losses in pipe flow through bends and fittings [2 Hrs]
4. Discharge measurement through rectangular/triangular notch [3 Hrs]
5. Study/Performance test of Pelton/Francis turbine [3 Hrs]
6. Study/Performance test of centrifugal/piston pump [3 Hrs]

Suggestions for instruction:

1. Give appropriate examples of surrounding.
2. Use SI units as well as possible.
3. Solving related problems in the class and give as home assignment.
4. Use as much as figures and diagrams with direction of flow.
5. Site visit of power plant, irrigation plant and drinking water supply system are advantage for this course

References:

1. B.S. Massy, "Fluid Mechanics", English Language Book Society and Van Nostrand Reinhold Company, London
2. F.M. White, "Fluid Mechanics", Mc Graw-Hill Book Company, Singapore
3. J.F. Douglas, J. M. Gasiorek and J. A. Swaffield., "Fluid Mechanics, Person Education Pvt. Ltd., Singapore
4. Jagdish Lal, "Fluid Mechanics and Hydraulics", Metropolitan Book Co. Private Ltd., New Delhi India
5. Jagdish Lal, "Hydraulic Machines", Metropolitan Book Co. Private Ltd., New Delhi India
6. R. K. Rajput, "Fluid Mechanics and Hydraulics Machines", S Chand and Company Ltd., New Delhi

Marks Specification for final evaluation:

Unit	Content	Course Hours	Marks
1	Properties of Fluid	3	5
2	Fluid Static	8	14
3	Kinematics of Fluid	2	4
4	Basic Equations of Fluid Flow	6	11
5	Losses on Pipe Flow	4	7
6	Flow Measurement	4	7
7	Dynamic Flow Measurement Action of Fluid	4	7
8	Water Turbines	8	14
9	Pumps	6	11
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks

Mechanics of Materials

EG 2205 RAE

Total: 5 Hrs/week
Year: II **Lecture: 3 Hrs/week**
Part: II **Tutorial: 1 Hrs/week**
Practical: Hrs/week
Lab: 2/2 Hrs/week

Course description:

This course provides a basic knowledge about the properties of material used in the field of engineering and the process of testing the material properties. It also gives brief concept of stress and their distribution on different types of loading**.**

Course Objectives:

After completion of this course student will be able to:

1. Identify the engineering material and their properties
2. Define the properties into numerical values
3. Understand concept of stress and strain
4. Understand the concept of bending stress and bending equation.

Course Content:

Unit 1: Introduction to Material **[6 Hrs]**

1.1 Classification of material: Metal, Polymer, Ceramics and Composites
1.2 Physical properties: luster, color, density
1.3 Mechanical properties: plasticity, elasticity, ductility, malleability, toughness
1.4 Electrical properties: conductivity and effect of temperature
1.5 Magnetic properties: ferro-magnet, para-magnet, dia-magnet and hysteresis loss
1.6 Thermal properties: specific heat, latent heat and thermal expansion

Unit 2: Engineering Material **[4 Hrs]**

2.1 Ferrous Alloys: classification, properties and uses
2.2 Copper and its alloys: classification, properties and uses
2.3 Aluminum and its alloys: classification, properties and uses
2.4 Glass: classification, properties and uses
2.5 Thermal Insulation material: classification, properties and uses

Unit 3: Material Testing **[6 Hrs]**

3.1 Introduction and Types: Destructive and non-Destructive Testing
3.2 Need of Testing
3.3 Destructive Testing: Basic concept and procedure of: Impact test, Tensile Test, Hardness Test (Rockwell, Brinell), Fatigue Test and Creep Test
3.4 Non-Destructive Test: basic concept and procedure of: Visual, ultrasonic, Radiography, magnetic particle test

Unit 4: Concept of Stress and Strain **[12 Hrs]**

4.1 Direct stress and direct strain – compressive and tensile.
4.2 Determination of direct stresses and strains for uniform sections
4.3 Determination of direct stresses and strains for stepped sections.
4.4 Statement of Hooke's law and definition of Young's Modulus of Elasticity.
4.5 Stress-strain diagram for tensile test on mild steel, explanation of elastic limit.
4.6 Limit of proportionality, yield point, ultimate stress, and breaking stress – actual and nominal.
4.7 Factor of safety.
4.8 Applications of Hooke's law to homogeneous and composite section.
4.9 Temperature stresses and strains for homogenous and composite section
4.10 Definition of shear stress, shear strain and modulus of rigidity.
4.11 Concept of single shear and double shear.
4.12 Determination of shear stress and shear strain for homogeneous sections.
4.13 Definition of linear strain, lateral strain and poison's ratio, volumetric strain, bulk modulus.
4.14 Relationship between elastic constants

Unit 5. Simple Bending **[10 Hrs]**

5.1. Theory of simple bending
5.2. Definition of moment of resistance, neutral axis, Section modulus.
5.3. Assumptions in simple theory of bending
5.4. Derivation and use of Theory of Bending Equation: - □/y = M/I =E /R.

Unit 6. Torsion **[4] Hrs**

6.1 Basic concept of Torque and angle of twist
6.2 Power transfer by a solid shaft
6.3 Basic concept of torsion equation and its Assumption

Unit 7. Column **[3 Hrs]**

7.1. Definition of column and strut
7.2. Columns with different support conditions
7.3. Eulers formula and its assumption.
7.4. Problem related to critical load with different support condition.

Tutorial: ***[15 Hrs]***

Tutorial 1: Simple problem of calculation of stress and Strain in Uniform section and Step Section of homogeneous material.

Tutorial 2: Simple problem of calculation of stress and strain in Uniform and Stepped Section with the use of principle of superposition.

Tutorial 3: Problem to find yield stress, ultimate stress, strain, modulus of elasticity, factor of safety from tensile test data.

Tutorial 4: Problem related to find linear strain, lateral strain and poison's ratio, volumetric strain, bulk modulus

Tutorial 5: Problem to find modulus of elasticity from relationship between elastic constants.

Tutorial 6: Simple problem using bending equation.

Tutorial 7: Simple problem related to solid shaft using torsion equation

Tutorial 7: Problem related to critical load with different support condition.

Practical/Laboratory: ***[15 Hrs]***

Lab 1: Identification of material from physical properties such as density, color, sound etc.
Lab 2: Performing Tensile test on standard specimen and draw stress-strain diagram
Lab 3: Performing Hardness test on standard specimen (Brinell, and Rockwell
Lab 4: Performing Fatigue test on standard specimen
Lab 5: Performing Impact test (Izod or Charpy) on standard specimen
Lab 6: Bending test of steel bar.
Lab 7: Demonstration of Column behavior and buckling: effect of end conditions on buckling load of beams.
Lab 8: Demonstration of stress develop in compound bar due to temperature effect.

References:

1. S. Risal, K. Gyanwali, "Material Science", Sigma Carts printing, Nepal
2. R.S. Khurmi, "Material Science", Laxmi publications (P) ltd
3. R.K. Bansal, "A text book of Strength of Material", Laxmi Publications (P) ltd
4. S.S. Bhavikatti, "Strength of Materials", Vikas Publishing House, New Delhi.
5. R.S. Khurmi, "Applied Mechanics and Strength of Materials",S. Chand & Co, Delhi

Marks specification for Final Examination:

Unit	Content	Course Hours	Marks
1	Introduction to Material	6	10
2	Engineering Material	4	7
3	Material Testing	6	10
4	Concept of Stress and Strain	12	22
5	Simple Bending	10	18
6	Torsion	4	7
7	Column	3	6
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks.

Machine Drawing

EG 2206 RAE

Year: II **Total: 4 Hrs/week**
Part: II **Lecture: 1 Hrs/week**
Tutorial: Hrs/week
Practical: 3 Hrs/week
Lab: Hrs/week

Course description:

This course deals with drawings about machines, elements of machine, standard graphical signs, symbols and notations, different type of fits with limits and tolerances, layout - installation, assembled and detail drawings of a plant or machine parts.

Course objectives:

After completing this course the students will be able to:

1. Read and sketch different universally accepted graphical signs, symbols and notations.
2. Understand the importance of limits, fits and tolerances in machines.
3. Draw few common machine elements with prevailing common practices.
4. Prepare working (detail & assembled) drawings.
5. Understand layout and installation drawings.

Course contents:

Theory

Unit: 1 Standard Symbols [1 Hr]

1.1 Introduction to machining symbols.
1.2 Introduction to surface roughness symbols and their meaning.
1.3 Introduction to welding symbols
1.4 Introduction to pipe and fittings symbols
1.5 Introduction to electronics and electrical symbols

Unit: 2 Limits, Tolerances and Fits [2 Hrs]

2.1 Introduction to Nominal and basic size, limits of size.
2.2 Introduction to fundamental deviations, tolerances, upper & lower deviation.
2.3 Introduction to clearance fit, interference fit & transition fit.
2.4 Introduction to hole basis & shaft basis system.
2.5 Introduction to go, no-go gauge, interchangeability & selective assembly.

Unit: 3 Gear, Pulley and Belt [2 Hrs]

3.1 Introduction to spur gearing, definitions of spur gear terminology & their definitions
- Construction of base circle.
- Construction of spur gear teeth (involute) profile.

3.2 Introduction to Pulleys & Belts

- Fast and loose pulleys
- V-belt pulleys
- Rope pulleys

Unit: 4 Working Drawing (Detail or production drawing) [3 Hrs]

4.1 Introduction – drawing layout, title box, bill of materials (part list)

4.2 Sketch of details of different components of a machine with free hand dimensioning.

4.3 Review of different type of sectioning - full, half, partial (or broken), revolved, removed and offset.

4.4 Review of common dimensioning types.

Unit: 5 Working Drawing (Assembly drawing) [7 Hrs]

5.1 Introduction to drawing layout, detail item list (bill of materials), drawing numbers (sheet numbers), sheet folding and filing styles.

5.2 Accepted norm and common practices for assembly drawing.

5.3 Introduction to sectioning & dimensioning concept for assembly drawing.

5.4 Introduction to sequences of preparing the assembly drawing.

5.5 Introduction to plant or machine layout and installation drawing

Practical (Class work sheet) [45 Hrs]

Sheet No 1: [3 Hrs]

Exercise in machining symbols, surface roughness symbols, welding symbols, pipe and fittings symbols, electronics and electrical symbols.

Sheet No 2: [6 Hrs]

1. Make the complete fit analysis of hole basis system. (Not less than 3 exercises)
2. Make the complete fit analysis of shaft basis system. (Not less than 3 exercises)

Sheet No 3: [6 Hrs]

1. Draw the profile of involute spur gear teeth. (Not less than 3 exercises)
2. Draw neatly the two views of fast and loose pulleys, rope pulleys and V-belt pulleys. (Not less than three exercises)

Sheet No 4: [9 Hrs]

Draw the detail drawings of the different machine components. (Not less than four exercises)

Sheet No 5: [21 Hrs]

5.1 Draw the assembly drawing of the different machine components with full sectional and half sectional views. (Not less than five exercises)

5.2 Observation and group discussion of minimum two sets of installation and layout drawings.

References:

1. N.D. Bhatt and V.M. Panchal, "Machine Drawing", Charotar Publishing House, India.
2. W.J. Luzadder, "Fundamental of Engineering Drawing", Prentice-Hall of India Pvt-Ltd., New Delhi, India
3. P.S. Gill, "Engineering Drawing", S. K. Kataraia & Sons, New Delhi, India
4. M. C. Luintel, "Engineering Drawing II", Heritage Publishers & Distributors Pvt. Ltd., Nepal
5. K.L. Narayanan, P. Kannaiah and K. Venkata Reddy, "Machine drawing", New Age International Publishers, India.

Third Year
Part I & II
(Fifth and Sixth Semester)

Fifth Semester
Year III Part I

Subjects:

1. EG 3101 RAE Refrigeration III
2. EG 3102 RAE Heating Ventilation and Air Conditioning II
3. EG 3103 RAE Industrial Engineering
4. EG 3104 RAE Trouble Shooting and Maintenance
5. EG 3106 RAE Industrial Attachment
6. EG 3105 RAE Computer Aided Drawing

Refrigeration – III
EG 3101 RAE

Total: 8 Hrs/week
Year: III **Lecture: 3 Hrs/week**
Part: I **Tutorial: 1 Hrs/week**
Practical: 4 Hrs/week
Lab: Hrs/week

Course Description:

This course is designed to make the students aware of food preservation techniques, defrosting techniques, solar energy and PV systems and cold rooms. This course will also guide students to cooling load estimation and its components.

Course Objectives:

After completion of this course, the students will be able to

1. Describe the food preservation methods
2. Carry-out defrosting and maintain defrosting mechanism in cooling components
3. Identify different types cold storage and carry-out the general maintenance of cold-storage
4. Describe the solar energy and identify solar collectors
5. Describe and carry-out maintenance of transport refrigeration system
6. Calculate cooling load for cold-storage considering all required loads
7. Complete the electrical wiring of the refrigerators having automatic defrost system

Course Contents;

Unit 1: Food Preservation **[6 Hrs]**

1.2 Factors contributing to food spoilage

1.3 Methods of food preservation

a. Conventional methods
b. Advanced methods (Vacuum drier, freeze drier)
c. Milk chilling and Pasteurization
d. Meat processing

Unit 2: Defrosting **[6 Hrs]**

2.1 Necessity of defrosting

2.2 Methods of defrosting (Manual defrosting, Pressure operated defrost system, Temperature operated defrost system, Water defrosting, Reverse cycle defrosting, Hot gas defrosting and Electric defrosting)

2.3 Safety to be observed while carrying out manual defrosting

Unit 3: Cold Storage and Walk-in Coolers **[10 Hrs]**

3.1 Cold storage chain for food preservation

3.2 Types and construction of cold storage

3.3 Ammonia plant for large cold-storages, drawbacks and safety

3.4 Split/rack units for cold storage

3.5 Construction of mid and large scale single and multi-chamber fruit and vegetable cold-storage. Types of evaporator used in such cold-storages
3.6 Different products and storage condition (Temperature and humidity)
3.7 Calculation of product load considering respiration load
3.8 Air Exhaust and Fresh air systems
3.9 Humidification and dehumidification systems as per products
3.10 Heat recovery systems
3.11 Introduction to controlled atmosphere (C.A)

Unit 4: Transport Refrigeration [3 Hrs]

4.1 Fundamentals of surface transportation methods
4.2 Refrigeration system in mobile refrigeration containers

Unit 5: Load Calculation for Cold Rooms [12 Hrs]

5.1 Storage requirements for Vegetables, Poultry, Meat, Dairy Products and Fruits (Product Load Calculation)
5.2 Determination of Wall Gain Load for cold rooms
5.3 Determination of Air Change Load for storage above and below freezing
5.4 Determination of Miscellaneous Loads; Lighting, Occupancy, equipment etc.
5.5 Determination of Cooling Capacity of a Refrigeration System for a cold room
5.6 Cool down time/congel time

Unit 6: Solar Energy [8 Hrs]

6.1 Nature of terrestrial radiation
6.2 Solar constant: Introduction and units
6.3 Solar Angles: Altitude, Azimuth, incident and declination
6.4 Measurement of solar radiation on earth's surface using pyranometer
6.5. Application of Solar PV systems in cold storage
6.6. Thermal backup for cold storage

Tutorial: ***[15 Hrs]***

1. **Tutorial 1 –** Food Preservation: calculations in milk chilling and meat processing, vacuum and freeze drier [3 Hrs]
2. **Tutorial 2 –** Defrosting: Different defrosting methods (Water operated, temperature operated, reverser cycle, hot gas and electric. [2 Hrs]
3. **Tutorial 3 –** Load calculation for cold rooms: Product storage requirements, determination of different cooling load components such as: wall, fresh air, lighting, occupancy, cool down time and heat recovery [6 Hrs]
4. **Tutorial 4 –** Solar energy: solar angles, measurement of solar radiation, solar PV systems [4 Hrs]

Practical/ Laboratory: ***[60 Hrs]***

1. Carryout defrosting of different commercial refrigeration system [4 Hrs]
2. Visit and prepare report of an industrial cold-storage with mechanical system diagram, cold-storage layout, product storage layout its operation and handling [12 Hrs]
3. Interact with the industrial cold-storage owner or technical person regarding storage method, handling procedure and temperature maintenance condition within the cold-storage [12 Hrs]
4. Draw the mechanical and electrical system diagram of a walk-in cooler and check the performance [8 Hrs]
5. Study the arrangement and identification of system components used in refrigerated transport vehicle [4 Hrs]
6. Study and analysis of solar water heater [8 Hrs]
7. Study and analysis of solar PV systems [8 Hrs]

References:

1. R.J. Dossat, "Principle of Refrigeration", John Wiley & Sons Ltd.
2. P.N. Ananthnarayan,"Basic Refrigeration and Air-conditioning
3. Domkundwar, S.C. Arora, "A course in refrigeration and Air-conditioning", Dhanpat Rai & Sons, India
4. R.S. Khurmi, "Textbook of refrigeration and air-conditioning", S. Chand.
5. T. E. Kissell, "Introduction to Solar Principles", Pearson

Marks specifications for final examination:

Unit	Content	Course Hours	Marks
1	Food Preservation	6	10
2	Defrosting	6	10
3	Cold Storage and Walk-in Coolers	10	18
4	Transport Refrigeration	3	6
5	Load Calculation for Cold Rooms	12	22
6	Solar Energy	8	14
	Total	**45**	**80**

Note: There might be minor deviations on the above specified marks.

Heating, Ventilation &Air-Conditioning II

EG 3102 RAE

Year: III
Part: I

Total: 7 Hrs/week
Lecture: 3 Hrs/week
Tutorial: 1 Hrs/week
Practical: 3 Hrs/week
Lab: Hrs/week

Course Description:

This course deals with the study of comfort air conditioning, construction and operation of various types of fans, air filters, humidifiers and pumps. It also deals with construction and working of various types of air filters as well as noise and noise control methods.

Course Objectives:

After this course the students will be able to

1. Explain and analyze working of various types of fans
2. Explain and analyze working of various types of air filters
3. Explain and analyze working of various types of humidifiers
4. Explain and analyze working of various types of pumps
5. Explain and analyze noise and methods of noise control

Course Contents:

Unit 1: Comfort Air-Conditioning **[12 Hrs]**

1.1 Factors affecting Human comfort
1.2 Thermodynamics of human body
1.3 Comfort zone and comfort chart
1.4 Factors governing the optimum effective temperature
1.5 Ventilation Requirements
1.6 Methods of ventilation

Unit 2: Fans/Blowers **[10 Hrs]**

2.1 Types of Fans (propeller, axial, centrifugal)
2.2 Fan characteristic curves
2.3 Fan Law
2.4 Selection of Fans
2.5 Construction and operation of Air Handling Unit (AHU)

Unit 3: Air Filters **[5 Hrs]**

3.1 Types and application of Air Filters (Dry Filters, HEPA, Viscous Filters, Wet Filters, Electric Filters)
3.2 Selection of Air Filters

Unit 4: Humidification and Dehumidification **[6 Hrs]**

4.1 Humidification process (Steam injection, Atomization, Evaporation, Air washer)

4.2 Dehumidification process
4.3 Representation of humidification and dehumidification on psychrometric chart

Unit 5: Pumps **[6 Hrs]**

5.1 Types of Pumps (Positive displacement, rotodyanamic)
5.2 Frequency controlled pump
5.3 Pump characteristic curves
5.4 Selection of pump

Unit 6: Noise and Noise Control **[6 Hrs]**

6.1 Fundamentals of sound measurements
6.2 Physiological Effects of Noise Pollution
6.3 Sources of noise in air-conditioning
6.4 Method of noise control
6.5 Noise attenuation in ducts and pipes

Tutorial: ***[15 Hrs]***

1. **Tutorial 1 -** Comfort air-conditioning: Factors affecting Human comfort, Thermodynamics of human body, Comfort zone and comfort chart, Ventilation Requirements [4 Hrs]
2. **Tutorial 2 -** Fans/Blowers: working principle and fan laws, selection of fans and blowers. [3 Hrs]
3. **Tutorial 3 -** Air-filters: Selection of air filters [1 hr]
4. **Tutorial 4 -** Humidification and Dehumidification: Humidification process (Steam injection, Atomization, Evaporation, Air washer), Dehumidification process, representation on psychrometric chart [3 Hrs]
5. **Tutorial 5 -** Pumps: working principle (positive displacement, rotodynamic) selection of pumps [3 Hrs]
6. **Tutorial 6 -** Noise and noise control: sound measurement [1 Hrs]

Practical/ Laboratory: ***[45 Hrs]***

1. Study of construction and performance of various fans [9 Hrs]
2. Study of construction and working of humidifier (steam, ultrasonic humidifier) [9 Hrs]
3. Study of construction, working and capacity determination of pumps [12 Hrs]
4. Pipe sizing for chilled water system [12 Hrs]
5. Study of effect of sound insulation and attenuator [3 Hrs]

References:

1. Domkundwar & Arora, "A course in Refrigeration and air conditioning", Dhanpat Rai and sons, 1682, Nai Sarak, Delhi – 110006, India
2. R.K. Rajput, "Refrigeration and Air-conditioning", S.K. Kataria & Sons, India
3. Carrier Air-conditioning Company, "Hand book of Air-conditioning Design", McGraw-Hill Book Company
4. E. G. Pita, "Air-conditioning Principles and System", Prentice-Hall of India Pvt. ltd., New Delhi-110006, India

Marks specifications for final examination:

Unit	Content	Course Hours	Marks
1	Comfort Air-Conditioning	12	22
2	Fans/Blowers	10	19
3	Air Filters	5	9
4	Humidification and Dehumidification	6	10
5	Pumps	6	10
6	Noise and Noise Control	6	10
	Total	**45**	**80**

Note: There might be minor deviations on the above specified marks.

Industrial Engineering
EG 3103 RAE

Total: 3 Hrs/week
Year: III **Lecture: 3 Hrs/week**
Part: I **Tutorial: Hrs/week**
Practical: Hrs/week
Lab: Hrs/week

Course Description:

This course deals with the fundamental concepts of Industrial Engineering, organization, management, leadership and supervisory, production management, marketing of products or services, materials management and inventory control, engineering economics and capital management required for supervisors and first line managers engaged in industrial activities

Course Objectives:

After completing the course, the student will be able to:
1. Describe the concept of organization and management
2. Understand the basic theories of management
3. Explain the various leadership behaviors of a manager
4. Explain the concept of production management and production control
5. Understand the process of marketing
6. Demonstrate the understanding of materials management
7. Apply the principles of engineering economics and capital management

Course contents:

Unit 1 Industrial Engineering **[2 Hrs]**

1.1 Definition and evolution of industrial engineering
1.2 Functions of industrial engineering: problem solving and decision making
1.3 Broad functional areas of industrial engineering

Unit 2 Organization and Management **[10 Hrs]**

2.1 Introduction to Organization
Classification of Organization (basic concept, advantages and disadvantages)
- Single ownership
- Partnership
- Joint stock company
- Cooperative
- Public
- Organization Structure
- Line organization
- Line and staff organization
- Functional organization
- Departmentalization

2.4 Management

- Introduction
- Functions of management
- Level of management
- Managerial skills
- Theory of management (Scientific, Administrative, Behavioral, Contingency)

Unit 3: Leadership and Motivation **[3 Hrs]**

3.1 Definition of leadership and motivation
3.2 Qualities of good leaders
3.3 Difference between manager and leader
3.4 Leadership styles
3.5 Theories of motivation (Theory X and Y, Maslow's hierarchy of needs)

Unit 4: Introduction to Production System **[7 Hrs]**

4.1 Introduction to a manufacturing plant
4.2 Classification of manufacturing processes
4.3 Plant location
- Importance of plant location
- Factors affecting plant location

4.4 Factory building and plant layout
- Types of factory building (basic features, pros and cons)
- Importance of plant layout
- Types of plant layout (basic features, pros and cons)

4.5 Material handling
- Factors affecting material handling (engineering and economics)
- Classification of material handling equipment

4.6 Store management: meaning, objectives, function of store

Unit 5: Production Planning and Control (PPC) **[10 Hrs]**

5.1 Introduction
5.2 Principle and objectives and functions of PPC
5.3 Types of production system (job, batch, continuous)
5.4 Forecasting methods, techniques and types
5.5 Inventory control (economic order quantity, ABC analysis)
5.6 Network techniques
- Critical path method (CPM)
- Program evaluation and review technique (PERT)

5.7 Definition and concept of quality, Quality control and Quality Assurance
5.8 Definition and concept of productivity
- Measurement of productivity
- Factors affecting productivity
- Productivity improvement techniques

Unit 6: Marketing of Product or Services **[3 Hrs]**

6.1 Definitions of market and marketing

6.2 Concept of marketing mix: product, price, place, promotion

6.3 Understanding consumer behavior

6.4 Functions of marketing

Unit 7: Maintenance Engineering **[5 Hrs]**

7.1 Introduction

7.2 Objectives of maintenance

7.3 Types of maintenance (Breakdown, Preventive, Reliability-centered, Risk based maintenance)

7.4 Maintenance activities (Inspections, Adjustment, Testing, Calibration, Rebuilt and Replacement)

Unit 8: Engineering Economics **[5 Hrs]**

8.1 Introduction to engineering economic decision

8.2 Concept of time value of money

8.3 Concept of Simple and compound interest rates, effective interest

8.4 Depreciation methods, straight line, declining balance method

8.5 Project Evaluation Techniques (simple payback period, NPV, IRR, MARR)

References:

1. K.K. Ahuja, "Industrial Management ", CBS Publishers and Distributors, India
2. R. Panneerselvam, "Production and Operations management", Prentice-Hall of India, Private Limited, Delhi.
3. S.K Sharma and Savita Sharma, "Industrial Engineering and Organization management", S.K. Kataria and Sons

Marks Specification for Final Examination:

Unit	Content	Course Hours	Marks
1	Industrial Engineering	2	4
2	Organization and Management	10	20
3	Leadership and Motivation	3	12
4	Introduction to Production System	7	12
5	Production Planning and Control (PPC)	10	8
6	Marketing of Product or Services	3	6
7	Maintenance Engineering	5	8
8	Engineering Economics	5	10
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks

Trouble Shooting and Maintenance

EG 3104 RAE

Total: 6 Hrs/week

Year: III **Lecture: 1 Hrs/week**

Part: I **Tutorial: Hrs/week**

Practical: 5 Hrs/week

Lab: Hrs/week

Course Description:

This course is designed to understand operation, maintenance, installation and troubleshooting of refrigeration and air conditioning systems in order to gain theoretical and practical knowledge.

Course objective:

After completion of this course, students will able to

1. Trouble shoot in RAC system
2. Carry out the maintenance of RAC system and components
3. Dismantle and assemble the system components
4. Perform repair of refrigerator, deepfreeze, and electrical systems.
5. Keep records and prepare report.

Course Contents:

Unit 1: Basic concept of Repair and maintenance of RAC **[5 Hrs]**

1.1 Introduction
1.2 Difference between Repair and Maintenance
1.3 Types of maintenance in RAC
1.4 Tools and Equipment used in Maintenance activities of RAC
1.5 Hazards in RAC maintenance work
1.6 Safety measures and Personal Protective Equipment.

Unit 2: Trouble-shooting of RAC **[10 Hrs]**

2.1. Concept of Trouble-shooting decision: Retrofitting, Redesign and Replacement
2.2. Factor affecting Trouble-shooting decision
2.3. Equipment records, machine cards and job cards
2.4. Fault and fault finding of RAC systems.
2.5.Failure analysis and concept of Fault tree analysis in RAC
2.6. Refrigerant Recycling and Environmental Concern

Practical/ Laboratory: ***[75 Hrs]***

Practical 1: Demonstration and practice use of Tools and Equipment of used in Repair and Maintenance of RAC. [5 Hrs]

Practical 2: Practice on accessing and rectifying problem due to leakage of refrigerant from refrigeration system [4 Hrs]

Practical 3: Practice on accessing and rectifying problem due to leakage of refrigerant from Air conditioning system: Split AC and VRF system [8 Hrs]

Practical 4: Practice on accessing and rectifying problem due to Chocking refrigerant from RAC system [8 Hrs]

Practical 5: Practice on Electrical fault finding and Charging refrigerant in hermetic and open type compressor [8 Hrs]

Practical 6: Practice on Condenser & Evaporator fans removal and assembly of shaft & bearings. [4 Hrs]

Practical 7: Practice on Dismantling and assembling of hermetic, semi hermetic and open type of compressors [8 Hrs]

Practical 8: Practice on fault finding and rectifying electrical and electronic fault in Domestic refrigerator, Deep freezer, Split AC and other commercial AC System. [8 Hrs]

Practical 9: Practice on Installation, charging and testing of small refabricated walk in cooler and split A/C [12 Hrs]

Practical 10: Practice on fault finding in HVAC trouble shooting simulator to familiar with different possible fault in HVAC in real practice. [10 Hrs]

References:

1. Langley, Billy C, "Air Conditioning and Refrigeration Troubleshooting Handbook"
2. Roberto de Aguiar Peixoto, "Manual for Refrigeration and Air Conditioning Technician", UNEP-2010
3. Manely HP, Fredrick J. Drake and Co., "Refrigeration Service Manual"

Evaluation Scheme:

Examination	Content	Marks
Internal (100 marks)	Attendance and job performance	50
	Lab/Practical Report	20
	Practical exam	30
Final (50 marks)	Viva voce	20
	Practical exam	30
Total		**150**

Note: Assign a faulty Refrigeration or AC system and students have to identify, rectify the fault and let the equipment in normal operating condition and evaluation is done on the basis of tool handling, knowledge about the fault finding technique and safety precaution.

Industrial Attachment

EG 3106 RAE

Total: 12 Hrs/week
Year: III **Lecture: Hrs/week**
Part: I **Tutorial: Hrs/week**
Practical: 12 Hrs/week
Lab: Hrs/week

Course description:

The students will be deputed to various organization/construction site having system related to refrigeration on a full time basis as a trainee or intern. At the end of the course, students will submit a report conforming to a standardized format along with the daily diary. Industrial attachment shall consist of exposure of world of work to learn skills and techniques in design, operation, diagnosis, maintenance and repair of refrigeration system based on the nature of the organization available locally or at national level.

Course objectives:

After completing the course, the students will be able to:
1. Develop the technical skills learn in the institute with the needs of the employer.
2. Increase self-confidence to face the real world of work.
3. Develop a space for the future career.
4. Ensure the standard of the training as per the market demand.
5. Sensitize with modern and new technologies applied in the industry.
6. Present the contents in front of a concerned mass of people.

Course contents:

1. A small team of student and suitable industry should be selected at the initial of the semester.
2. Each team should be given an orientation before releasing from the institute.
3. Each team should prepare a dairy of daily activities.
4. Each team should submit a project report including the following.
    - Page of approval from the industry
    - Profile of the industry
    - Layout of the industry.
    - List of machines and material handling equipment.
    - Process flow chart within the industry
    - Special technological aspect learnt during the internship/attachment.
    - General problems of the workshop/industry
    - Suggestions for improvement of selected aspect of the problems (store management, layout improvement, work study etc).
    - List of daily activities performed
    - Photographs of major involvement

Evaluation Scheme for Final Examination:

Examination	Content	Marks
Internal (240 marks)	Evaluation from Industry • Attendance • Job performance • Report	 20 150 30
	Evaluation from institute	40
Final (160 marks)	Group Report and Viva voce on Institute	160
Total		**400**

Computer Aided Drawing

EG 3105 RAE

Total: 4 Hrs/week

Year: III **Lecture: 1 Hrs/week**

Part: I **Tutorial: Hrs/week**

Practical: 3 Hrs/week

Lab: Hrs/week

Course description:

This course deals with generation of two-dimensional and three-dimensional drawing using SolidWorks. It also deals with the advanced part modeling and component assembly.

Course objectives:

After completing this course the students will be able to:

1. draw two dimensional objects using SolidWorks
2. draw three dimensional objects using solid modeling, sweep and loft techniques.
3. produce workshop drawing with bill of materials.

Course contents:

Unit 1: Introduction **[1 Hr]**

1.1 Using the Interface/Loading SolidWorks
1.2 Using the
1.3 Running Programs
1.4 Exit Programs
1.5 Searching for a file or folder
1.6 Wild card searches
1.7 Saving and copying files
1.8 Resizing windows
1.9 Toolbars
2.0 Getting helps

Unit 2: Basic Solid Works Essentials **[4 Hrs]**

2.1 Feature based, parametric solid modeling
2.2 Sketched Features and Operation Features, Example of shape features
2.3 Solid Works terminology: Feature Manage design tree Graphics Area, parametric, Driving dimensions, geometric relations, solid modeling, Associative feature, Design intents, and Solid Works model
2.4 Creating New files using temples
2.5 User Interface, tools bars, customize toolbars, view control
2.6 Basic geometry terminology: Axis, plane origin, face edge vertex
2.7 Document properties, system options

Unit 3: Introduction to Sketching **[4 Hrs]**

3.1 Introduction to sketching
3.2 Default Planes
3.3 Creating a 2D sketch
3.4 Status of a sketch, governing rules in sketches
3.5 Design Intent
3.6 Sketch Relations, add sketch relations, dimensions
3.7 Dimensions: smart dimensions, adding dimensions, modify tool
3.8 Sketch fillet
3.9 Sketch tips

Unit 4: Part Modeling **[10 Hrs]**

4.1 Basic modeling terminology: Feature plane, sketches, extrusion, boss cut
4.2 Choosing a sketch plane
4.3 view ports,
4.4 Hole wizards
4.5 Fileting: Fillet types, Filleting rules, Fillet property Manager, constant radius fillet
4.6 Edit color
4.7 Make a drawing from a part: Creating drawing, drawing template
4.8 General procedure for creating a drawing
4.9 Model views: Insert a model view, drawing views, isometric view added to drawing
4.10 Dimensions: Driven dimensions, dimensioning drawings, general drawing rules for dimensions, dimensions guidelines, import dimension into a drawing, manipulating dimensions

Unit 5: Advanced Part Modeling **[11 Hrs]**

5.1 Sweeps:
5.1.1 Overview of revolve feature,
5.1.2 Creating a revolve feature
5.2 Loft
5.2.1 Loft feature overview,
5.2.2 Creating an offset plane for loft,
5.2.3 Setting up planes
5.2.4 Sketch profile for loft
5.2.5 Move a sketch to a different plane
5.2.6 Examples

Unit 6: Assembly Modeling **[5 Hrs]**

6.1 Types of assembly: Top down assembly modeling and bottom up assembly modeling
6.2 Manual assembly configurations
6.3 Assembly design tables
6.4 Assembly editing

Unit 7: Plotting Drawings **[10 Hrs]**

7.1 Drawing Sheets and Views
7.2 Dimensions
7.3 Annotations
7.4 Sheet formats and Templates
7.5 Assembly drawing views
7.6 Bill of Materials and tables

Practical/ Laboratory: ***[45 Hrs]***

Unit 1: Introduction **[3 Hrs]**

1.1 Familiarization with Software Environment, Setting up Drawing

Unit 2: Basic Drawing Commands **[6 Hrs]**

2.1 2D Sketching using Straight Lines
2.2 2D Sketching using Circle and Arc
2.3 2D Sketching using Ellipse, spline and Polygon

Unit 3: Add relation on 2D Sketchings **[3 Hrs]**

3.1 2 D sketching with fully constrained

Unit 4: Fine Tuning Drawings **[6 Hrs]**

4.1 Creating Hatch, Working with Layers, Group and Blocks
4.2 Isometric Drawing: Object and Text

Unit 5: 3-D Solid Modeling **[4 Hrs]**

5.1 3D Drawing: Solid Modeling
5.2 3D Drawing: using sweeps and loft

Unit 6: Plotting drawings **[3 Hrs]**

6.1 Plotting 2D and 3D Drawings

Project

Project 1: Drawing of standard mechanical components: **[6 Hrs]**

Spring, Nut Bolt, Gear, Cam Profile, etc

Project 2: Drawing of assembly and detailed drawing of simple mechanical systems.[6 Hrs]

Project 3: Drawing of an electrical distribution in two story housed design **[4 Hrs]**

Project 4: Drawing of pipe line connection in a household refrigerator system **[4 Hrs]**

Reference:

1. James D. Bethune, "Engineering Design and Graphics with SolidWorks", Pearson,
2. Matt Lombard, "SolidWorks 2010", Wiley Publishing, Inc
3. “SolidWorks User's Guide”, Autodesk,

Evaluation Scheme:

Examination	Content	Marks
Internal (60 marks)	Attendance	10
	Job performance	30
	Practical exam	20
Final (40 marks)	Practical exam	40
Total		**100**

Marks specification for final examination:

1. 2D Sketching including drawing setup by using 2D Draw tools [15 marks]
2. Isometric drawings of five different machine components [10 marks]
3. Assembly drawing composed by minimum 10 families and produce bill of material for the fabrication drawing [15 marks]

Sixth Semester
Year III Part II

Subjects:

1. EG 3201 RAE Estimating and Costing
2. EG 3202 RAE Heating Ventilation and Air Conditioning II
3. EG 3201 MG Entrepreneurship Development
4. EG 3203 ME Occupational Hygiene and Safety
5. EG 3204 RAE Project
6. EG 3203 RAE Building Services
7. Elective: (One of the following)

   EG 3205 RAE.1 a. Automobile Air Conditioning
   EG 3205 RAE.2 b. Transport Refrigeration
   EG 3205 RAE.3 c. Refrigerant Management
   EG 3205 RAE.4 d. Energy Audit and Management

Estimation and Costing
EG 3201 RAE

Year: III
Part: II

Total: 4 Hrs/week
Lecture: 4 Hrs/week
Tutorial: Hrs/week
Practical: Hrs/week
Lab: Hrs/week

Course Description:

This course is designed to make the students well aware of estimating process and requirement of estimation and costing of refrigeration and air-conditioning equipment installation, Repair, maintenance and fabrication.

Course Objectives:

After completion of this course the students will be able to;

1. Explain different terminologies regarding estimation and costing
2. Estimate the different cost involved in refrigeration and air-conditioning installation
3. Estimate the cost of service to be provided in refrigeration business
4. Understand and explain the tender document
5. Prepare the specification for different components used in Refrigeration and Air-conditioning industries

Course Content:

Unit 1: Estimation and Costing **[10 Hrs]**

1.1 Introduction
1.2 Objectives of Estimation
1.3 Objectives of costing
1.4 Method of costing: Job order costing, Batch costing, Unit Operation costing, Process costing, Multiple cost method, departmental costing, Service costing.
1.5 Methods of estimation
1.6 Constituents of Estimation
1.7 Difference between Estimation and Costing
1.8 Elements of Cost: Material, Labor, Expenses
1.9 Ladder of cost
1.10 Allocation of Overhead
1.11 Problem related to calculate selling price using ladder of cost.

Unit 2: Estimation of Work **[14 Hrs]**

2.1 Estimation of Labor hour
2.2 Estimation of material and Equipment cost
2.3 Estimation of operation and maintenance cost
2.4 Estimation of System Components: Electrical cable and other components.
2.5 Problem related to estimation of labor, material and operation and maintenance of RAC system

Unit 3: Estimation of System Installation **[12 Hrs]**

3.1 Estimation of cost of installation of central AC in commercial building
3.2 Estimation of cold storage house
3.3 Estimation of Ice Bank
3.4 Problem related to estimation of air conditioning system, cold storage and ice bank from given specification of work.

Unit 4: Specification Development **[8 Hrs]**

4.1 Writing of specification for refrigeration system and components
4.2 Writing of specification for Duct work and air-conditioning components and system installation

Unit 5: Practices on Estimation **[8 Hrs]**

5.1 Practices on preparing Bill of Quantities (BoQ), Specification and Estimation of Refrigeration and Air-Conditioning (RAC) System and components.
5.2 Practice on calculating the total cost, including tax and profit for given project

Unit 6: Tender Document **[8 Hrs]**

6.1 Introduction
6.2 Essential components of tender document
6.3 Study various tender documents concerning Refrigeration and Air-conditioning works
6.4 Prepare tender document for RAC system/component installation and commissioning

References:

1. T. R. Banga, S.C. Sharma, "Mechanical Estimating and Costing including contracting", Khanna Publisher
2. R.S. Khurmi, "Mechanical Estimating Methods", Khanna Publication

Marks specification for Final Examination:

Unit	Content	Course Hours	Marks
1	Estimation and Costing	10	16
2	Estimation of Work	14	18
3	Estimation of System Installation	12	16
4	Specification Development	8	10
5	Practices on Estimation	8	10
6	Tender Document	8	10
	Total	**60**	**80**

Note: There might be minor deviations on the above specified marks.

Heating, Ventilation & Air-Conditioning III

EG 3202 RAE

Total: 7 Hrs/week
Year: III **Lecture: 3 Hrs/week**
Part: II **Tutorial: 1 Hrs/week**
Practical: 3 Hrs/week
Lab: Hrs/week

Course Description:

This course deals with the study of Chillers, AHUs, FCUs, Heating system, water conditioning and VRF/VRV systems.

Course Objectives:

After the completion of this course, students will be able to:

1. Explain and maintain working of various types of chillers
2. Explain and maintain working of various types of AHUs/FCUs
3. Explain the working of heating system
4. Explain the working of VRF system
5. Understand water conditioning system
6. Perform basic thermal load calculation

Course contents:

Unit 1: Chillers **[8 Hrs]**

1.1 Application of chillers
1.2 Types, construction and operation of Chillers (DX, flooded type shell & tube, shell & coil)
1.3 Cooling towers and selection

Unit 2: Air Handling Units and Fan Coil Units **[6 Hrs]**

2.1 Introduction
2.2 Types of AHUs (ceiling concealed, treated fresh air-TFA, ceiling suspended, floor standing, single skin, double skinned, high pressure, low pressure)
2.3 Types of FCUs (ceiling concealed, ceiling suspended, floor standing, single skin, double skinned, high pressure, low pressure)
2.4 Introduction to air scrubbers (dry and wet)

Unit 3: Heating System **[6 Hrs]**

3.1 Warm air furnace heating system
3.2 Hot water heating system (Boiler, Heat pump, solar)
3.3 Steam heating system
3.4 Floor heating systems

Unit 4: Water Conditioning **[6 Hrs]**

4.1 Sources of water for chillers
4.2 Constituents and characteristics of water
4.3 Water quality requirement for chiller and boiler
4.4 Fundaments of water treatments
4.5 Water treatment plants
4.6 Types and causes of Scale and Deposit
4.7 De-scaling methods

Unit 5: Inverter Based Variable Refrigerant Flow/Volume (VRV/VRF) Types of Air-Conditioning System **[11 Hrs]**

5.1 Principle of operation of inverter system
5.2 Operation and application of VRV/VRF system
5.3 Limitation of VRV/VRF system
5.4 Comparison of 1:1 Split and VRV/VRF system
5.5 Principles of VRF AC system design

Unit 6: Automotive Air-conditioning System **[2 Hrs]**

6.1 Operation of automotive Air-conditioning
6.2 Components of automotive Air-conditioning

Unit 7: Cooling and Heating Load Components **[6 Hrs]**

7.1 Introduction
7.2 Concepts of cooling/heating load components
7.3 Equipment selection
7.4 Sample calculation for residential buildings using thumb rule

Tutorial: ***[15 Hrs]***

1. Heating systems: Thermal calculations of different heating systems such as: furnace, steam, floor and hot water [4 Hrs]
2. Water conditioning: Water quality measurement, water treatment [2 Hrs]
3. VRV/VRF Systems: Principles of VRV/VRF system design, pipe sizing, diversity and selection of indoor and outdoor units [4 Hrs]
4. Cooling/heating load components: Calculation of different heating load components for simple residential building, equipment selection [5 Hrs]

Practical/Laboratory: ***[45 Hrs]***

1. Study of construction and working of various types of chillers [3 Hrs]
2. Study of construction and working of various types of AHUs [3 Hrs]
3. Study of construction and working of various types of FCUs [3 Hrs]

4. Thermal load calculation of residential buildings [12 Hrs]
5. VRV/VRF system design [12 Hrs]
6. Visit local Air-conditioned spaces and submit report – The report should include type of HVAC systems used and its working principle, maintenance procedures, measurement and controls, merits and demerits of the existing system and suggestions for improvements. [12 Hrs]

References:

1. Domkundwar & Arora, "A course in Refrigeration and air conditioning, Dhanpat Rai and Sons, New Delhi – 110006, India
2. R.K. Rajput, "Refrigeration and Air-conditioning", S.K. Kataria & Sons, India
3. Carrier Air-conditioning Company, "Hand book of Air-conditioning Design", McGraw-Hill Book Company
4. E. G. Pita, "Air-conditioning Principles and System", Prentice-Hall of India Pvt. ltd.

Marks specifications for final examination:

Unit	Content	Course Hours	Marks
1	Chillers	8	12
2	Air Handling Units and Fan Coil Units	6	11
3	Heating System	6	11
4	Water Conditioning	6	11
5	Inverter Based Variable Refrigerant Flow/Volume (VRV/VRF) Types of Air-Conditioning System	11	20
6	Automotive Air-conditioning System	2	4
7	Cooling and Heating Load Components	6	11
	Total	**45**	**80**

Note: There might be minor deviations on the above specified marks.

Entrepreneurship Development

EG 3201 MG

Year: III **Total: 5 Hrs. /week**
Semester: II **Lecture: 3 Hrs./week**
Tutorial: Hr./week
Practical: 2 Hrs./week
Lab: Hrs./week

Course Description:
This course is designed to provide the knowledge and skills on formulating business plan and managing small business. The entire course deals with assessing, acquiring, and developing entrepreneurial attitude; skills and tools that are necessary to start and run a small enterprise.

Course Objectives:
After completion of this course students will be able to:
1. Understand the concept of business and entrepreneurship;
2. Explore entrepreneurial competencies;
3. Analyze business ideas and viability;
4. Learn to formulate business plan with its integral components and
5. Manage small business.

Course Contents:

Theory

Unit 1: Introduction to Business & Entrepreneurship: [9 Hrs.]
a. Overview of entrepreneur and entrepreneurship
b. Wage employment, self- employment and business
c. Synopsis of types and forms of enterprises
d. Attitudes, characteristics & skills required to be an entrepreneur
e. Myths about entrepreneurs
f. Overview of MSMEs (Micro, Small and Medium Enterprises) in Nepal

Unit 2: Exploring and Developing Entrepreneurial Competencies: [9 Hrs.]
a. Assessing individual entrepreneurial inclination
b. Assessment of decision-making attitudes
c. Risk taking behavior and risk minimization
d. Creativity and innovation in business
e. Enterprise management competencies

Unit 3: Business identification and Selection: [4 Hrs.]
a. Sources and method of finding business idea(s)
b. Selection of viable business ideas
c. Legal provisions for MSMEs in Nepal

Unit 4: Business plan Formulation: **[18 Hrs.]**

a. Needs and importance of business plan
b. Marketing plan
    - Description of product or service
    - Targeted market and customers
    - Location of business establishment
    - Estimation of market demand
    - Competitors analysis
    - Estimation of market share
    - Measures for business promotion
c. Business operation plan
    - Process of product or service creation
    - Required fix assets
    - Level of capacity utilization
    - Depreciation & amortization
    - Estimation office overhead and utilities
d. Organizational and human resource plan
    - Legal status of business
    - Management structure
    - Required human resource and cost
    - Roles and responsibility of staff
e. Financial plan
    - Working capital estimation
    - Pre-operating expenses
    - Source of investment and financial costs
    - Per unit cost of service or product
    - Unit price and profit/loss estimation of first year
f. Business plan appraisal
    - Return on investment
    - Breakeven analysis
    - Risk factors

Unit 5: Small Business Management: **[5 Hrs.]**

a. Concept of small business management
b. Market and marketing mix
c. Basic account keeping

Practical

Unit 1: Overview of Business & Entrepreneurship [2 Hrs.]

1. Collect business information through interaction with successful entrepreneur

Unit 2: Exploring and Developing Entrepreneurial Competencies [2 Hrs.]

1. Generate innovative business ideas

Unit 3: Product or service Identification and Selection [2 Hrs.]

1. Analyze business ideas using SWOT method

Unit 4: Business Plan Formulation [22 Hrs.]

1. Prepare marketing plan
2. Prepare operation plan
3. Prepare organizational and human resource plan
4. Prepare financial plan
5. Appraise business plan
6. Prepare action plan for business startup

Unit 5: Small Business Management [2 Hrs.]

1. Prepare receipt and payment account
2. Perform costing and pricing of product and service.

Occupational Hygiene and Safety

EG 3203 ME

Year: III
Part: II

Total: 3 Hrs/week
Lecture: 3 Hrs/week
Tutorial: Hrs/week
Practical: Hrs/week
Lab: Hrs/week

Course Description:

This course deals about hygiene and safety as the most important thing for every operator, worker, technician and engineer while working in the industry. It explains different safety requirement and measures of control for protection from concerned hazard.

Course Objectives:

After completing this course the students will be able to

1. Differentiate and explain industrial hygiene and safety
2. Induce safety awareness
3. Locate unsafe locations and activities on shop floor and take corrective actions
4. Understand legal requirements regarding industrial hygiene and safety

Course content:

Unit 1: Introduction to Industrial Hygiene and Safety [4 Hrs]

1.1 Scope of industrial hygiene and safety
1.2 Cost and liability of industrial hygiene and safety
1.3 Accident, causes of accident and accident prevention methods
1.4 Principles and practices of safety management

Unit 2: Occupational Safety and Health [4 Hrs]

2.1 Legal Provisions by ILO, National Acts, labour laws for safety and health
2.2 Occupational Safety Rights
2.3 Industrial Hazard record system
2.4 Hazard Management system

Unit 3: Industrial Environment [4 Hrs]

3.1 Sanitation in industry
3.2 Ventilation system
3.3 Lighting system
3.4 Heating system

Unit 4: Electrical Safety [4 Hrs]

4.1 Effects of electric current on health
4.2 Electrical accidents

4.3 Electrical safety standards and regulations
4.4 Prevention of electrical accidents
4.5 Safety requirements for electric installation
4.6 Protective equipment for electrical safety

Unit 5: Fire Prevention and Control [3 Hrs]

5.1 Fire hazards
5.2 Accident prevention principle
5.3 Fire control methods

Unit 6: Noise Pollution and It's Control [4 Hrs]

6.1 Effect of noise on health
6.2 Standard requirements for industrial noise levels
6.3 Noise control principle and methods
6.4 Personal protective equipment

Unit 7: Air Pollution [3 Hrs]

7.1 Classification of pollutants in industry
7.2 Sources of pollutants
7.3 Permissible limits
7.4 Control of the environment

Unit 8: Electromagnetic Radiation [4 Hrs]

8.1 Health hazards due to electromagnetic radiation
8.2 Permissible limits of electromagnetic radiation
8.3 Electromagnetic radiation protection principle
8.4 Personal protective equipment

Unit 9: Industrial Vibration [2 Hrs]

9.1 Causes of vibration
9.2 Vibration minimizing techniques

Unit 10: Material Handling [4 Hrs]

10.1 Factors affecting selection of means for handling of materials
10.2 Mechanical material handling
10.3 Handling of dangerous chemicals

Unit 11: Machine Guarding [4 Hrs]

11.1 Legal requirements
11.2 Assessment of guards
11.3 Types of guards
11.4 Design aspect of guards

Unit 12: Physical and Chemical Hazards and Safety Measures in Various Operations [5 Hrs]

12.1 Arc welding and gas welding
12.2 Forging
12.3 Casting
12.4 Machining
12.5 Automotive works

Suggestions for instructions:

1. Demonstration of protective devices
2. Visit to industries
3. Demonstration of using various instruments and equipment

References:

1. William Handley, "Industrial Safety Handbook", McGraw Hill
2. H. V. Krishnan, "An introduction to Safety Engineering and Management"
3. M. K. Polter, "Occupational Health & Safety in Manufacturing Industries", Mir Publishers, Moscow
4. H. W. Henrich, "Industrial Accident Prevention", McGraw Hill

Marks Specification for final examination:

Unit	Content	Course Hours	Marks
1	Small Business Management	4	6
2	Occupational Safety and Health	4	6
3	Industrial Environment	4	8
4	Electrical Safety	4	8
5	Fire Prevention and Control	3	4
6	Noise Pollution and It's Control	4	8
7	Air Pollution	3	4
8	Electromagnetic Radiation	4	8
9	Industrial Vibration	2	4
10	Material Handling	4	8
11	Machine Guarding	4	8
12	Physical and Chemical Hazards and Safety Measures in Various Operations	5	8
	Total	**45**	**80**

Note: There might be minor deviation on above specified marks.

Project

EG 3204 RAE

Total: 7 Hrs/week

Year: III **Lecture: Hrs/week**

Part: II **Tutorial: Hrs/week**

Practical: 7 Hrs/week

Lab: Hrs/week

Course Description:

This subject includes the fabrication of any basic component(s) on the basis of the knowledge and the skill learnt during the previous courses in a team. A small team of the students will be given an outline of device/item/tool/system for the purpose. The finished product along with the final project report and viva voce will be conducted for final evaluation.

Course Objective:

The main objective of this course are:

1. To develop basic hand on skills.
2. To use skills and knowledge that they have acquired.
3. Get exposure on industrial work environment and work ethics.
4. To play role on a team work.
5. To prepare collaborative edition of the final project report.

Course content:

- A small team should be selected at the initial of the semester.
- Each team should be given a different group work regarding the simple fabrication of a functional/ daily life product that they can complete.
- Each team should submit a project report including the following.
    - Introduction to the content of the project.
    - Objective
    - Application and working of the component
    - Procedure of fabrication
    - List of materials used.
    - Part and Assembly drawing
    - Conclusion
    - References

Note: The student will be allocated a team of guides comprising of the theory teacher and the practical teacher for the project work. The student shall also consult the library and internet for completion of the work.

Evaluation Scheme:

Examination	Content	Marks
Internal	Attendance, Product and job performance	120
Final	Group Report and Viva voce	80
Total		**200**

Building Services
EG 3203 RAE

Total: 8 Hrs/week
Year: III **Lecture: 4 Hrs/week**
Part: II **Tutorial: Hrs/week**
Practical: Hrs/week
Lab: 4 Hrs/week

Course Description:

This course deals with the services of utilities in a modern building. It covers HVAC, Hydronic system, electrical requirement, lift and escalators, special plumbing works, firefighting technologies required in buildings.

Course Objectives:

After completing this course, the student will be able to:

1. explain the basic design knowledge for MEP works
2. explain Concept of Building Service
3. deal with the efficient use of energy in a given system

Course content:

Unit: 1 Heating, Ventilation and Air-Conditioning (HVAC) System [8 Hrs]

1.1 Introduction to HVAC
  1.1.1 Fundamentals
  1.1.2 Codes and Standards
1.2 Basic Components of Air-Conditioning and Refrigeration machines
1.3 Air Conditioning Concepts Fire Protection (Awareness)
1.4 Fan/Blower Selection
  1.4.1 Selection of Motor HP
  1.4.2 Selection Fan/Blower RP

Unit: 2 Hydronic System [8 Hrs]

2.1 Classification of Water Piping
2.2 Pipe sizing for chill water system
2.3 Fittings used in the HVAC piping System
2.4 Valves used in the HVAC piping System
2.5 Function of Valves
2.6 Openings for CHW pipes passing through Wall
2.7 Pump Head Calculation
2.8 Selection of Pump

Unit: 3 Electrical Services [8 Hrs]

3.1 Electrical Equipment Selection & Sizing used in installation
  3.1.1 Control devices, Measuring devices

3.1.2 Circuit protection devices
3.1.3 Transformers, Diesel generators
3.1.4 Capacitors, Bus ducts, Bus bars, Cables (HT/LT) & wires, Motors & Pumps
3.1.5 Luminaries –General & Emergency
3.1.6 Isolators & socket outlets
3.1.7 UPS/Inverter & Battery banks
3.1.8 Earthing or Grounding, Lightning arrestor

3.2 Lifts and Escalators
3.2.1 Work Principle, components and function
3.2.2 Safety and Maintenance of Lift and Escalator

Unit: 4 Plumbing Services [16 Hrs]

4.1 Plumbing Systems
4.1.1 Fundamentals of Plumbing System
4.1.2 Introduction, Definitions, Concepts
4.1.3 Fixtures, Faucets and Fixture fittings; Wash Basin, Water Closet, Bidet, Bath Tube, Shower, Urinals, Kitchen Sink, Floor Drain

4.2 Design of Domestic Water Supply and Distribution System
4.2.1 Requirements of Water Supply System, Water Demand Calculations
4.2.2 Water Storage Calculations
4.2.3 Internal Water Supply System
4.2.4 Over Head tank distribution system
4.2.5 Design Procedure for Internal Water Supply System
4.2.6 Flow rate(q) & Loading Unit(z) – From Probability equation
4.2.7 Hazen Williams Formula for Head Loss Calculation
4.2.8 Internal Water Supply Pipe sizing calculations
4.2.9 Pumping Calculations – HP/Watts
4.2.10 Material used in Internal water supply system
4.2.11 External Water Supply System
4.2.12 Number of Population served
4.2.13 Number of Fixtures served by Each Pipe
4.2.14 Design Procedure for External Water Supply System
4.2.15 External Water Supply Pipe Sizing Calculations
4.2.16 Material used in External water supply system
4.2.17 Water Supply Schematic Layout
4.2.18 Use of Continuity Equation, Manning's Formula and Rational Formula

Unit: 5 Introduction to Water Treatment Plant [4 Hrs]

5.1 Purpose and operation
5.2 Water Treatment Plant: layout, components and function

Unit: 6 Fire Fighting Systems **[6 Hrs]**

6.1 Fire Fighting Systems Processes
- 6.1.1 Fundamentals of Fire Protection System
- 6.1.2 Introduction and Definitions
- 6.1.3 Requirements of Fire Protection System
- 6.1.4 Fire extinguisher
- 6.1.5 Hose Reel
- 6.1.6 Dry Riser
- 6.1.7 Wet Riser
- 6.1.8 Down Comer
- 6.1.9 Yard Hydrant
- 6.1.10 Automatic Sprinkler system

6.2 Introduction to the Fire Detection Application

Unit: 7 Principles of Fire Fighting System **[6 Hrs]**

7.1 Design of Fire Protection Schematic Layouts and Pipe Sizing

7.2 Design of Fire Water Storage and Pumping Calculations Project Work

Unit: 8 Codes & Standards to be Followed **[4 Hrs]**

8.1 Nepal electricity rules.

8.2 National electrical code of India (NEC)

8.3 National building code of Nepal (NBC)

8.4 Regulations of local fire authorities

8.5 Requirements stipulated by Pollution Control Board for Noise, Air & Water Pollution

Practical/ Laboratory: ***[60 Hrs]***

1. Study of Air Distribution System at Commercial Space, Hospital and Hotels that include detail duct design, calculation, gauge selection as per SMACNA Standard **[12 Hrs]**
2. Selection of Diffusers (Square, Round, Jet) and Grilles, Damper (Auto/Manual), Duct materials and insulation materials used in HVAC Industry **[4 Hrs]**
3. Study of CAV & VAV **[4 Hrs]**
4. Study of Public Health Engineering (PHE) system of Commercial Space, Hospital and Hotels **[6 Hrs]**
5. Study of Fire Fighting system of Commercial Space, Hospital and Hotels **[6 Hrs]**
6. Fire Fighting and PHE System Design **[8 Hrs]**
7. Visit to nearest Commercial Space or Hospitals or Hotels and Submit Reports-Report on Mechanical Electrical Plumbing (MEP) Works **[8 Hrs]**
8. MEP System Design using Revit MEP/AutoCAD MEP **[12 Hrs]**

References:

1. R.K. Rajput, "Refrigeration and Air-conditioning", S.K. Kataria & Sons, India
2. R.S. Khurmi, "Textbook of Refrigeration and Air-Conditioning", S. Chand.
3. Ashtag Hussain, "Electric Machines", Dhanpat Rai and Co.
4. Vivekanand Cr Mohan, "Design and Practical Handbook on Plumbing Paperback"
5. Sidney M Levy, "MEP Data book: Construction Data books Hardcover"

Mark Specification for Final Examination:

Unit	Content	Course Hours	Marks
1	Heating, Ventilation and Air-Conditioning (HVAC) System	8	10
2	Hydronic System	8	10
3	Electrical Services	8	10
4	Plumbing Services	16	24
5	Introduction to Water Treatment Plant	4	4
6	Fire Fighting Systems	6	8
7	Principles of Fire Fighting System	6	8
8	Codes & Standards to be Followed	4	6
	Total	**60**	**80**

Note: There might be minor deviation on the above specified marks.

Automobile Air Conditioning (Elective)

EG 3205 RAE.1

Total: 6 Hrs/week
Year: III **Lecture: 3 Hrs/week**
Part: II **Tutorial: Hrs/week**
Practical: Hrs/week
Lab: 3 Hrs/week

Course Description:
This course has been designed to introduce students with refrigeration and air conditioning system in passenger vehicles. This course will help the students to develop basic concepts about refrigeration, its systems, identify basic components of the systems and their uses in automobiles.

Course objectives:

1. To understand the concept of air conditioning system and its working principle used in automobiles
2. To understand the concept of repair and maintenance of Automobile A/C system.
3. To design, construction and application of automotive air conditioning.
4. To understand the service procedures, including diagnosing, testing, evacuating and recharging of automobile A/C systems.

Course Content:

1. **Introduction to Automobile Air-Conditioning & Refrigeration** **[4 Hrs]**
   - 1.1 Introduction to refrigeration and air conditioning in automobiles
   - 1.2 Methods of refrigeration
   - 1.3 Applications of refrigeration and air conditioning in automobiles
   - 1.4 Air conditioning for passengers
   - 1.5 Refrigeration vehicles; types, system and applications
   - 1.6 Cryogenic vehicles: types, system and applications

2 **Heat and Psychrometric Charts for Automobiles** **[4 Hrs]**
   - 2.1 Sources of heat inside a vehicle
   - 2.2 Comfort charts
   - 2.3 Factors affecting comfort
   - 2.4 Effective temperature
   - 2.5 Ventilation requirements

3 **Components of Air-Conditioning System in Automobile** **[12 Hrs]**
   - 3.1 Compressor, compressor clutch and major components of clutch assembly
   - 3.2 Condensers types and condensers electric fans
   - 3.3 Evaporators and their types
   - 3.4 Thermal expansion and thermal expansion block valve
   - 3.5 Orifice tube and accumulators

3.6 Hoses and charging ports
3.7 Air mixing damper
3.8 Switch and electrical circuit for manual and automatic
3.9 Protective devices: Clutch Diode, Thermal protection switch, refrigerant pressure switch, Condenser fan control, pressure transducer, Engine Control Module (ECM), Body Control Module (BCM), Power Train Module (PCM)
3.10 Sensors: sun load, ambient temperature

4 **Automobiles Air-Conditioning Systems** **[6 Hrs]**
4.1 Classification and layouts
4.2 Expansion block valve system
4.3 Parallel flow condenser system
4.4 Orifice tube system
4.5 Expansion valve dual system

5. **Load Calculations and Analysis** **[10 Hrs]**
5.1 Design considerations for achieving desired inside/room conditions with respect to prevailing outside/environment conditions
5.2 Cooling and heating load calculations
5.3 Load calculations for automobiles: Metabolic load, Radiation load, Ambient load, Exhaust Load, Engine load, Ventilation load, AC Load,
5.4 Effect of air conditioning load on engine performance in terms of loss of available peak torque/power and fuel consumption
5.5 Case study

6 **Automobile Air distribution Systems** **[3 Hrs]**
6.1 Distribution ducting, sizing, supply/return ducts
6.2 Diffusers
6.3 Ventilation
6.4 Air noise level
6.5 Layout of duct systems for automobiles and their impact on load calculations

7 **Automobile Air-Conditioning Service** **[6 Hrs]**
7.1 Tools used in maintenance of air conditioning system
7.2 Testing, diagnosis & trouble shooting of air conditioning system: preliminary steps of testing, Performance test, Causes of Faulty Performance, causes of noise and unpleasant odors.
7.3 Air conditioner maintenance and service:
7.3.1 Removing and replacing components: compressor, filter, sensors
7.3.2 Recovery and recycling
7.3.3 Evacuation and charging
7.3.4 Leak detection and detectors
7.3.5 Lubrications and flushing
7.3.6 Joining of refrigerant pipeline

7.3.7 Refrigerant gas charging procedure
7.3.8 Servicing of heater system

Practical/Laboratory: ***[45 Hrs]***

1. Demonstration of air conditioning system
2. Study of automobile air conditioning system
3. Dismantling and assembly of automobile air conditioning system
4. Charging of refrigerant in compressor
5. Flushing of contaminated A/C system
6. Case study on different vehicles having air conditioning and refrigeration system

References:

1. Crouse & Anglin "Automotive Air-conditioning", McGraw Hill Publications.
2. Jerry Clemons, "How to Repair Automotive Air-Conditioning & Heating Systems", Car Tech Publications
3. S. C. Arora & S. Domkundwar, "A Course in Refrigeration and Air Conditioning", Dhanpar Rai & Sons Publication, New Delhi, India.
4. C. K. Rajput, "A Text Book of Refrigeration and Air conditioning", S. K Kataria & Sons publication, New Delhi, India.
5. Andrew D. Althouse, Carl H. Thrnouist, and Alfred F. Bracciano, "Modern Refrigeration and Air Conditioning", Galgotia Publication, New Delhi, India.
6. "ASHRAE Handbooks on Fundamentals and HVAC Applications", Americal Society of Heating Refrigerating and Air Conditioning Engineers, Tullie Circle, Atlanta, USA

Marks Specification for final examination:

Unit	Content	Course Hours	Marks
1	Introduction to Automobile Air-Conditioning & Refrigeration	4	8
2	Heat and Psychrometric Charts for Automobiles	4	8
3	Components of Air-Conditioning System in Automobile	12	16
4	Automobiles Air-Conditioning Systems	6	12
5	Load Calculations and Analysis	10	16
6	Automobile Air distribution Systems	3	6
7	Automobile Air-Conditioning Service	6	12
	Total	**45**	**80**

Note: There might be minor deviation on the above specified marks.

Transport Refrigeration and Air-conditioning (Elective)

EG 3205 RAE.2

Total: 6 Hrs/week
Year: III **Lecture: 3 Hrs/week**
Part: II **Tutorial: Hrs/week**
Practical: Hrs/week
Lab: 3 Hrs/week

Course Description:

This course has been designed for students who want to specialize in transport refrigeration and air-conditioning. The subject deals introduction to transport refrigeration, different types of systems used and their repair and maintenance.

Course Objectives:

After completion of this course the students will be able to

1. Explain the methods and use of transport refrigeration
2. Explain the different systems used in various means of transport
3. Repair the refrigeration system of refrigerated trucks/vans
4. Repair and maintain air-conditioning system of air-conditioned car/bus

Course Contents:

Unit 1: Introduction to Transport Refrigeration **[8 Hrs]**

1.1 Need of Refrigerated Transport
1.2 Refrigerated Trucks
1.3 Refrigerated Train
1.4 Marine Refrigeration
1.5 Refrigerated air cargo

Unit 2: Methods of Refrigeration in Road Transport **[4 Hrs]**

2.1 Liquid Nitrogen
2.2 Dry Ice
2.3 Mechanical Refrigeration
2.4 System, Components and controls of above listed systems

Unit 3: Refrigerated Trucks/Vans **[9 Hrs]**

3.1 Body Insulation
3.2 Refrigeration systems
3.3 System components
3.4 Control system

Unit 4: Bus Air-Conditioning **[9 Hrs]**

4.1 Heating systems
4.2 Cooling systems
4.3 System components
4.4 Control system

Unit 5: Car Air-Conditioning **[6 Hrs]**

5.1 Heating systems
5.2 Cooling systems
5.3 System components
5.4 Control system

Unit 6: Train Air-Conditioning **[3 Hrs]**

6.1 Heating systems
6.2 Cooling systems
6.3 System components
6.4 Control systems

Unit 7: Marine Air-Conditioning **[3 Hrs]**

7.1 Heating system
7.2 Cooling system
7.3 System components
7.4 Control systems

Unit 8: Airplane Air-Conditioning **[3 Hrs]**

8.1 Heating system
8.2 Cooling system
8.3 System components
8.4 Control systems

Practical/ Laboratory: ***[45 Hrs]***

1. Observe and draw the diagram of various systems used in refrigerated trucks/vans as per arrangement. [6 Hrs]
2. Identify all the components used in refrigerated trucks/vans. [6 Hrs]
3. Check the system performance of a refrigerated trucks/vans. [9 Hrs]
4. Check the system performance of an air-conditioned car/ bus. [9 Hrs]
5. Charge the refrigerant in car air-conditioner [6 Hrs]
6. Operate air-conditioning systems in passenger bus. [9 Hrs]

References:

1. "Refrigeration and Air-conditioning", New Age International Publisher
2. "Operation and Service manual, Transport Air-conditioning Unit, Carrier"

Marks specifications for final examination:

Unit	Content	Course Hours	Marks
1	Introduction to Transport Refrigeration	8	16
2	Methods of Refrigeration in Road Transport	4	8
3	Refrigerated Trucks/Vans	9	16
4	Bus Air-Conditioning	9	16
5	Car Air-Conditioning	6	12
6	Train Air-Conditioning	3	4
7	Marine Air-Conditioning	3	4
8	Airplane Air-Conditioning	3	4
	Total	**45**	**80**

Note: There might be minor deviations on the above specified marks

Refrigerant Management (Elective)

EG 3205 RAE.3

Total: 6 Hrs/week
Year: III **Lecture: 3 Hrs/week**
Part: II **Tutorial: Hrs/week**
Practical: Hrs/week
Lab: 3 Hrs/week

Course Description:

This course deals with the global environmental issues and teaches the role of the Ozone Depleting Substances (ODS) and the mechanism of Ozone depletion. It deals with the recovery recycling of Ozone depleting refrigerants and Good Practices in Refrigeration that should be followed.

Course Objectives:

After completing the course, the students would be able to:

1. Explain the global environmental issues like Ozone Depletion and Global warming
2. Conduct the recovery techniques
3. Explain the constituents and applications of environmentally safer refrigerants

Course Content:

Unit 1: Refrigerants **[4 Hrs]**

- 1.1 Characteristics of refrigerants
- 1.2 Nomenclature of refrigerants, commercial name, generic name and chemical formula of major refrigerants
- 1.3 Refrigerant footprints

Unit 2: Ozone Layer **[4 Hrs]**

- 2.1 Layers of Earth's atmosphere and the role of Ozone layer in the stratosphere
- 2.2 Formation of Ozone in near ground levels and their effects
- 2.3 The process of the formation and destruction of ozone

Unit 3: The Process of Ozone Depletion **[8 Hrs]**

- 3.1 Ozone depletion mechanism and Ozone Depleting Substances
- 3.2 Causes and effects of Ozone depletion
- 3.3 Effect on Ozone by Fully halogenated and not fully Halogenated refrigerants
- 3.4 Ozone Depleting Potential (ODP) of refrigerants

Unit 4: Global Warming **[8 Hrs]**

- 4.1 Global Warming Mechanism
- 4.2 Causes and effects of Global Warming
- 4.3 Global Warming potential of Refrigerants

Unit 5: Refrigerant Recovery Equipment and Their Operation **[8 Hrs]**

- 5.1 Refrigerant Recovery, meaning and processes
- 5.2 Recovery equipment
- 5.3 Push/Pull liquid recovery
- 5.4 Vapor transfer recovery

Unit 6: New Refrigerant **[5 Hrs]**

6.1 Introduction and usage of HC refrigerant
6.2 Low GWP refrigerants
6.3 Safety issues

Unit 7: Good Practices in Refrigeration **[8 Hrs]**

7.1 Montreal Protocol and Nepalese initiatives in control of ODS
7.2 Recycling and Reclaim
7.3 Recycling equipment and process
7.4 Current Zero ODP refrigerants and their applications

Practical/ Laboratory: ***[45 Hrs]***

1. Handling of refrigerant recovery equipment: recovery machine, vacuum pump, recovery cylinder, weighting machine, filter dryer [12 Hrs]
2. Recovery of refrigerant from a refrigerator [6 Hrs]
3. Recovery of refrigerant from an air conditioner [6 Hrs]
4. Charging of recycled refrigerant [6 Hrs]
5. Safety consideration on handling of refrigerant R290, R32 [6 Hrs]
6. Study of standard recycling practice of refrigerant and reporting [9 Hrs]

References:

1. Arora & Domkundwar, "A Course in Refrigeration and Air Conditioning", Dhanpat Rai & Co., India
2. Gilbert M. Masters & Wendell P. Ela, "Introduction to Environmental Engineering and Science", Pearson Education Inc. Publishing, as Pearson, Printice Hall

Marks Specification for final examination:

Unit	Content	Course Hours	Marks
1	Refrigerants	4	4
2	Ozone Layer	4	4
3	The Process of Ozone Depletion	8	16
4	Global Warming	8	16
5	Refrigerant Recovery Equipment and Their Operation	8	16
6	New Refrigerant	5	8
7	Good Practices in Refrigeration	8	16
	Total	**45**	**80**

Note: There might be minor deviation on above specified marks

Energy Audit and Management (Elective)

EG 3205 RAE.4

Total: 6 Hrs/week

Year: III **Lecture: 3 Hrs/week**

Part: II **Tutorial: Hrs/week**

Practical: Hrs/week

Lab: 3 Hrs/week

Course Description:

This course deals with the fundamentals of energy auditing and management. It covers the components of energy audit, its techniques, different instruments required in basic energy auditing process. Students will understand basic principles and importance of energy audit, analysis and conservation.

Course Objectives:

After completing this course the student will be able to:

1. Understanding the basic principle and importance behind energy audit
2. Understand the energy consumption patterns of common electro-mechanical equipment
3. Deal with the efficient use of energy in a given system with energy audit
4. Optimize the use of energy system under varying conditions
5. Optimize the source of energy that produce goods and provide services with the least cost and least environmental effect.

Course content:

Unit 1: Introduction **[4 Hrs]**

- 1.1 Types of energy
- 1.2 Definition and objective of energy audit and management
- 1.3 Principles of energy management
- 1.4 Energy Management Skills.
- 1.5 Energy Management Strategy

Unit 2: Energy Auditing Technique **[5 Hrs]**

- 2.1 Energy Audit - Types & Methodology
- 2.2 Needs of energy audits
- 2.3 Methods of energy auditing and System approach
- 2.4 History of energy use
- 2.5 Familiarization with the systems
- 2.6 Existing energy consumption pattern
- 2.7 Field survey
- 2.8 Approach to analysis of fuel and electricity figures
- 2.9 Energy saving potential by good housekeeping, electricity, waste heat recovery

Unit 3: Energy Audit Instruments **[6 Hrs]**

- 3.1 Principal and working of Electrical Measuring Instruments (Voltmeter, ammeter, Power factor meter, Frequency analyzer)

3.2 Principal and working of Speed measuring devices (Tachometer contact/ non- contact type, Stroboscope)
3.3 Principle and working of temperature measuring devices (Contact and non- contact type thermometers, Infrared thermometers)
3.4 Principle and working of flue gas analyzer (Combustion analyzer, Fuel efficiency monitor, Fyrite)
3.5 Pressure and velocity Measurement (Bourdon gauge, Manometers, Anemometer)
3.6 Flow Measurement of steam, water and air (Pitot Tube and manometer)
3.7 Humidity Measurement and leak Detectors
3.8 Measure of illumination using Lux meter

Unit 4: Energy Conservation and Management [16 Hrs]

4.1 **Electrical energy survey:** Understanding the bill, tariffs, analysis, instruments for electrical energy survey, efficiency calculation; Energy conservation in distribution system and distribution system arrangement; Power factor management and problems associated with poor power factor.
4.2 **Energy conservation in Lighting System:** Types of lighting equipment; Energy conservation opportunities in lighting system.
4.3 **Energy conservation in Buildings:** Building heat gain, Types of heating, ventilating and air-conditioning, thermal insulation, solar passive architecture.
4.4 **Energy conservation in Steam Generation, Distribution:** losses in boilers, boiler and furnace efficiency calculation; Losses in steam distribution system and condense recovery.
4.5 **Waste heat recovery in processing plant**: concept and recovery devices

Unit 5: Electrical Energy Demand and Load Management [5 Hrs]

5.1 Maximum demand: demand charges, Cost saving from demand control
5.2 Demand control potential: load factor, load curves and demand profiles, identification of load
5.3 Method of demand control: manual and automatic
5.4 Load management

Unit 6: Energy Audit in Heating, Ventilation and Air-Conditioning Section [4 Hrs]

6.1 Need of energy audit in HVAC
6.2 Area of audit: control devices, heating, ventilation, cooling, power consumption
6.3 Checklist for audit of HVAC
6.4 Performance measurement (COP)
6.5 Load measurement: Compressor, fans
6.6 Heat loss: refrigerant pipe, ducts
6.7 Performance evaluation of cooling tower
6.8 Energy efficiency ratio (EER), Integrated energy efficiency ratio (IEER)

Unit 7: Energy Audit Reporting [5 Hrs]

7.1 Energy Audit Reporting format
7.2 Understanding energy cost
7.3 Benchmarking and Energy Performance
7.4 Matching energy usage to requirement
7.5 Maximizing System Efficiency

Practical/Laboratory: ***[45 Hrs]***

At least 6 labs related to the energy consumption pattern of electrical and mechanical equipment and investigate the energy saving opportunity. Following experiment can be conducted in lab:

1. Experiment on heat transfer
2. Experiments on refrigeration and air-conditioning COP measurement
3. Experiments on compressor
4. Stag gas measurement and analysis
5. Use of electrical energy meter and calculations
6. Electrical light flux measurements
7. Experiment on electrical motor
8. Experiments on pumps and fans
9. Exercise on energy auditing from simple to complex one in step
10. Project on specific energy auditing

Field Visit:

Field visit be conducted for energy audit to the local industry to observe HVAC system in operation.

References:

1. Paul O' Callaghan, "Energy management", McGraw Hill
2. Charles M. Gottschalk, "Industrial Energy Conservation", John Wiley and Sons
3. Wayne C. Turner, "Energy Management Handbook", John Wiley and Sons
4. Cape Hart, Turner and Kennedy, "Guide to Energy Management"

Marks Specification for final examination:

Unit	Content	Course Hours	Marks
1	Introduction	4	8
2	Energy Auditing Technique	5	8
3	Energy Audit Instruments	6	12
4	Energy Conservation and Management	16	28
5	Electrical Energy Demand and Load Management	5	8
6	Energy Audit in Heating, Ventilation and Air-Conditioning Section	4	8
7	Energy Audit Reporting	5	8
	Total	**45**	**80**

Note: There might be minor deviation on above specified marks

Experts Involved in Curriculum Revision, 2022

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1	Dr.bMahesh Chandra Luintel	Professor	Pulchowk Campus, IOE
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3	Dr. Surya Prasad Adhikari	Associate Professor	Pulchowk Campus, IOE
4	Vishwa Prasanna Amatya	Associate Professor	Pulchowk Campus, IOE
5	Dr. Krishna Prasad Shrestha	Assistant Professor	School of Engineering, KU
6	Raj Kumar Chaulagain	Lecturer	Thapathali Campus, IOE
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13	Amrit Baniya	HVAC, Consultant	Kalyani Engineering Consultancy Pvt. Ltd.