

**CURRICULUM
FOR
DIPLOMA OF ASSOCIATE
ENGINEER

IN
DAE in Mechanical Technology with specialization in HVAC&R

(3-Year Course)
June, 2026**

CURRICULUM SALIENT

Qualification Title	DAE in Mechanical Technology with specialization in HVAC&R
Qualification Stream	Technical
Duration of Course	3 Years (Annual System)
Total Training Credit Hours	73
Entry Level	Matric with Science.
Annual Intake	As approved by the respective TEVTA
Methodology	Theory 40% ; Practical 60%
Instructional Medium	Urdu / English

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DESCRIPTION	PAGE NO
SCHEME OF STUDIES (ARCHITECTURE TECHNOLOGY)	
CURRICULUM DAE 1 st YEAR	
CURRICULUM DAE 2 nd YEAR	
CURRICULUM DAE 3 rd YEAR	

HEATING, VENTILATION, AIR CONDITIONING & REFRIGERATION (HVAC&R)

SCHEME OF STUDIES-Rev. 2026

1st Year					
Sr.#	CODE	SUBJECT	T	P	C
1.	GEN 111	Islamiat & Pak Studies	1	0	1
	TTQ / Civic 111	Tarjuma-tul-Quran	1	0	1
2.	ENG 112	English	2	0	2
3.	MATH 113	Applied Mathematics - I	3	0	3
4.	PHY 122	Applied Physics	1	3	2
5.	CH 112	Applied Chemistry	1	3	2
6.	MT 101	Technical Drawing	0	3	1
7.	ET 103	Applied Electricity	2	3	3
8.	COMP 182	ICT Fundamentals	1	3	2
9.	HVAC 103	Principles of Refrigeration	2	3	3
10.	HVAC 111	Safety in HVAC&R Systems	1	0	1
11.	HVAC 122	Workshop Practice-I	0	6	2
		a) Metal Shop	0	3	1
		b) Machine Shop/Welding Shop	0	3	1
		Total	15	24	23

2nd Year					
Sr.#	CODE	SUBJECT	T	P	C
1.	GEN 201	Islamiat & Pakistan Studies	1	0	1
	TTQ / Civic 211	Tarjuma-tul-Quran	1	0	1
2.	MATH 223	Applied Maths-II	3	0	3
3.	MGM 242	Business Management & Accounting	2	0	2
4.	PHY 212	Applied Physics / Applied Mechanics	1	3	2
5.	HVAC 205	Principle of Air Conditioning	3	6	5
6.	HVAC 213	Applied Thermodynamics in HVAC&R Systems	2	3	3
7.	HVAC 263	Engg. Architectural and Computer Aided Drawing	1	6	3
8.	HVAC 273	Advance Refrigeration	3	0	3
9.	HVAC 283	HVAC&R Workshop Practice-II	1	6	3
		Total	18	24	26

3rd Year					
Sr.#	CODE	SUBJECT	T	P	C
1.	GEN 301	Islamiat & Pakistan Studies	1	0	1
2.	MGM 321	Business Communication	1	0	1
3.	MGM 322	Industrial Management & Human Resource Development	2	0	2
4.	ELR 301	Basic Electronics Applied to HVAC&R Systems	0	3	1
5.	HVAC 325	Air conditioning System Design & Sustainability	3	6	5
6.	HVAC 332	Water & Air Distribution	2	0	2
7.	HVAC 344	Controls & instrumentation	3	3	4
8.	HVAC 352	Industrial Refrigeration & Air-conditioning Machines & Equipment	2	0	2
9.	HVAC 362	Heat Transfer and Refrigeration Calculations	2	0	2
10.	HVAC 373	Workshop Practice – III	0	9	3
11.	MGM- 381	Entrepreneurship	1	0	1
		Total	17	21	24
		GRAND TOTAL	50	69	73

اسلامیات / مطالعہ پاکستان

GEN III

ٹی پی سی
1 0 1
کل وقت: 20 گھنٹے

حصہ اول اسلامیات

حصہ دوم مطالعہ پاکستان

موضوعات حصہ اول اسلامیات

کتاب و سنت

(ا) قرآن مجید

1- تعارف قرآن مجید 2- نزول قرآن 3- مکی و مدنی سورتوں کی خصوصیات 4- وحی کی اقسام 5- پندرہ منتخب آیات مع ترجمہ

- 1.1 تنالوا البر حتی تنفقوا مما تحبون
- 1.2 واعتصموا بحبل اللہ جمیعاً ولا تفرقوا
- 1.3 ولا یجر منکم شأن قوم علی ان لا تعدلوا
- 1.4 ان اللہ یمرکم ان تودوا الامانات الی اهلها
- 1.5 ان اللہ یمر بالعدل والاحسان
- 1.6 ان الصلوٰۃ تنہی عن الفحشاء والمنکر
- 1.7 لقد کان لکم فی رسول اللہ سۃ حسنہ
- 1.8 ان اکر منکم عند اللہ اتقاکم
- 1.9 وما آتاکم الرسول فخرزوا وما نہی عنہوا انتہوا
- 1.10 ولوفوا بالعہد
- 1.11 وما شروہن بالمعروف
- 1.12 یمحق اللہ الربو ویربب الصمدات
- 1.13 واصبر علی ما اصابک
- 1.14 وقولوا قولا سدیداً
- 1.15 ان الدین عند اللہ الاسلام

(ب) سنت

- 1- سنت کی اہمیت
- 2- دس منتخب احادیث مع ترجمہ و تشریح

- 1- انما الاعمال بالنيات
- 2- اہمیت لایم مکارم الاخلاق
- 3- لایوم من احدکم حق یحب الاخیہ ما یحب لنفسہ
- 4- المسلم من سلم المسلمون من سبہ المسلمون من لسانہ ویدہ
- 5- فی امننت باللہ سلم استقم
- 6- حیرکم خیرکم ذالہ
- 7- سباب المسلم فسوق وقتالہ کفر
- 8- المؤمن اخو المؤمن
- 9- کئی المسلم عسی المسلم حیر لم یجمعہ و مالہ و فرقہ
- 10- ایۃ المنافق ثلاث اذا حدیث کذب و اذا وعاو تمن خان و اذا وفنا خلف

دین اسلام

- 2.1 ہندام کے بنیادی مقصد کی وضاحت اور انسان کی اخروی و مادی زندگی پر ان کے اثرات

1- توحید

2- رسالت

3- آخرت

4- ملاکہ

5- اسلامی کتب

7.2 عبادات

- 1- نماز 2- روزہ 3- حج 4- زکوٰۃ

مندرجہ بالا عبادات کی اہمیت و فضیلت، حکمتیں اور انسان کی اخروی و معاشرتی زندگی پر ان کے اثرات

حصہ اول
حصہ اسلامیات

مدرسہ کی مقاصد

۱۔ قرآن مجید

عمومی مقصد: طالب علم یہ سمجھنے کے قابل ہو کہ اسلام کی تعلیمت کا اصل سرچشمہ قرآن مجید ہے
خصوصی مقصد: طالب علم اس قابل ہو جائے گا کہ
قرآن مجید کی تشریف کر سکے گا

۱۰

قرآن مجید کے نزول کی صورت بیان کر سکے

۱۱

قرآن مجید کی کئی روایتی سورتوں کی پہچان کر سکے

۱۲

مختار آیات کا ترجمہ و تشریح کر سکے

۱۳

عمومی مقصد: یہ سمجھنے کے قابل ہو جائے گا کہ مختار قرآنی آیات کے ذریعے اسلامی تعلیمت کا مفہوم کیا ہے

قرآنی آیات کا ترجمہ و تشریح کر سکے

۱۴

قرآنی تعلیمت کی روشنی میں اپنی اور معاشرتی اصلاح کر سکے

۱۵

۲۔ سنت

۱۶

عمومی مقصد: طالب علم سنت نبوی کی اہمیت اور ضرورت کو اچھی طرح سمجھنے کے قابل ہو جائے گا
خصوصی مقصد:

سنت کی تشریف بیان کر سکے

۱۷

سنت کی اہمیت و ضرورت کی وضاحت کر سکے

۱۸

سنت کی روشنی میں امور حسنہ پر عمل کر سکے

۱۹

مختار احادیث نبویہ

۲۰

عمومی مقصد: احادیث کی روشنی میں اخلاقی اقدار سے سمجھائی حاصل کر سکے

خصوصی مقصد: احادیث کا ترجمہ و تشریح کر سکے

رسول اللہ ﷺ کے امور حسنہ کا پورا، کاملہ مدعا ہو سکے

دین اسلام

عمومی مقاصد: دین اسلامی کے بنیادی مقاصد اور عبادات کے بارے میں جان سکے اور بیان کر سکے
خصوصی مقاصد

لفظ دین اسلام کے لغوی اور اصطلاحی معنی بیان کر سکے

اسلام کے بنیادی مقاصد کی اہمیت بیان کر سکے

اسلام کے بنیادی مقاصد سے انسان کی انفرادی و اجتماعی زندگی پر پڑنے والے اثرات بیان کر سکے

عبادت کے لفظی و اصطلاحی معنی بیان کر سکے

عقیدے اور عبادت کا فرق بیان کر سکے

عبادت (نماز، روزہ، حج، زکوٰۃ) کے فوری احکامات اور انسانی زندگی پر ان کی اثرات بیان کر سکے

اسلامی مقاصد و عبادت کے مطابق اپنی زندگی ڈھل کر ایک اچھا مسلمان بن سکے

اغیر مسلم طلباء کے لئے)

GEN III

نصاب اختلاقیات سائنسوں

حصہ دوم علامہ پاکستان

ن ج ی

1 0 1

کل وقت - 20 گھنٹے

موضوعات

اختلاقیات کی تعریف اور اہمیت

اختلاقیات کا معیار (قانون، عقل، الہی کتب)

سندرجہ اہل اخلاق کی وضاحت

☆ وقت اہل

☆ واداری

☆ نظم و ضبط

☆ راست گوئی

☆ صبر و استقامت

☆ حوصلہ مندی

☆ وقت کی پابندی

☆ صفائی

☆ اعتدال

☆ باہمی احترام

☆ مصلحت

نصاب اخلاقیات (سہ ماہی)

تعمیری مقاصد

- عمومی مقاصد: اعلیٰ تعلقات کی وجہ سے ملتی ترقی میں تامل قدر بخشنا کر سکے
- خصوصی مقاصد: طالب علم سے ایسا جھٹکا ہو گا کہ
- ۱۵ موضوعات کا مطلب بیان کر سکے
- ۱۶ عملی زندگی سے مثالوں کی نشاندہی کر سکے
- ۱۷ اپنی شخصیت اور معاشرے پر موضوعات کے مثبت اثرات پیدا کرنے کے طریقے بیان کر سکے
- ۱۸ وراثت داری کی اہمیت بیان کر سکے
- ۱۹ وفا داری کی اہمیت بیان کر سکے
- ۲۰ لکھ و ضبط کی تعلیمات بیان کر سکے
- ۲۱ صدق بیان کی ضرورت بیان کر سکے
- ۲۲ حوصلہ مندی کے فوائد بیان کر سکے
- ۲۳ وقت کی پابندی کے فوائد بیان کر سکے
- ۲۴ صفائی اور باہمی اختیار سے حسن کلر کی کو بیان کر سکے
- ۲۵ مصلحت کے فوائد بیان کر سکے

حصہ دوم	مذاہد پاکستان	نصابہ: اسل لائن (Gen III)	کل وقت 12 گھنٹے
موضوعات			
1۔	حجرتِ نمر: مسلمان قوم میں آزادیِ فکر کی تاریخ مسلمانوں میں سیاسی آزادی کی اہمیت اور ضرورت - ذاتی و جسمانی غلامی کے قصص		
2۔	نظریہ پاکستان		
3۔	قیام پاکستان کی اساس (دین اسلام) قیام پاکستان کی غرض، غایت نظریہ پاکستان کی وضاحت۔ نظریہ پاکستان اور مردمِ اقبال اور قائد اعظم کے ارشادات کی روشنی میں		
4۔	نظریہ پاکستان کا تاریخی پسو		
5۔	محمد بن قاسم کی فتوح، محمد بن قاسم کی فتوح اور شہدائے الہ آباد کی تیاری عملات سید احمد شہید کی تحریک مجاہدین		
6۔	قلمی تحریکیں		
7۔	علی گڑھ - تحریک اصلاحیہ (پروٹسٹ - مدرسہ الاسلام - (سندھ) اسلامیہ کالج، ایفٹور) انجمنِ حمایتِ اسلام (الہ آباد)		

مطالعہ پاکستان (حصہ دوم)
درس کا مقصد
حریت فکر:

- عمومی مقصد
- طالب علم یہ جان لے کہ اسلام میں اور مسلمان قوم میں آزادی فکر کی کیا اہمیت ہے
- خصوصی مقاصد
- ☆ حریت فکر کا معنی و مفہوم بیان کر سکے
- ☆ آزادی فکر کی اہمیت بیان کر سکے
- ☆ خصوصاً "اسلام میں آزادی اظہار رائے کی اہمیت بیان کر سکے
- ☆ ذاتی غلامی کے قومی سطح پر نقصانات کے بیان کر سکے
- ☆ دوسری غلامی قومی سطح پر نقصانات بیان کر سکے
- نظریہ پاکستان
- عمومی مقصد:
- نظریہ پاکستان (دین اسلام) سے پوری طرح واقفیت ہو جائے
- خصوصی مقاصد:
- ☆ نظریہ کی تعریف بیان کر سکے اور اس کی وضاحت کر سکے
- ☆ نظریہ پاکستان کی تعریف کر سکے اور اس کا مفہوم بیان کر سکے
- ☆ علامہ اقبال اور قائد اعظم کے فرمودات کی روشنی میں نظریہ پاکستان بیان کر سکے
- نظریہ پاکستان کا تاریخی پس منظر
- عمومی مقصد
- ☆ نظریہ پاکستان کے تاریخی پس منظر سے واقفیت حاصل کر سکے
- خصوصی مقاصد:
- ☆ محمد بن قاسم کے بارے میں بیان کر سکے

- ۶۰ محمد بن قاسم کے ہندوستان پر حملہ کی وجہ بیان کر سکے
- ۶۱ محمد بن قاسم کے ہندوستان پر حملہ کے اثرات بیان کر سکے
- ۶۲ بیان کر سکے کہ ہندوستان میں ہندو مسلم دو قومی نظریہ کا نکلنا آغاز کیا ہے
- ۶۳ محمد الف ثانی کی ملی خدمات بیان کر سکے
- ۶۴ شہد ولی اللہ کی ملی خدمات بیان کر سکے
- ۶۵ محمد الف ثانی اور شہد ولی اللہ نے جو تبلیغ دین اور مسلمانوں میں سیاسی شعور پیدا کیا اسے بیان کر سکے

علمی تحریکیں

عمومی مقصد

- ۶۶ برصغیر کی ملی تحریکوں سے آگاہی حاصل کر سکے
- ۶۷ قصور من متعصب:
- ۶۸ ملی مرکز - راجہ بندہ - تحریک العلماء مدرسہ السلام، اسلامیہ کالج - ایمسن حمایت اسلام نے تعلیم کے ذریعہ سیاسی شعور مسلمانوں میں پیدا کیا اسے بیان کر سکے
- ۶۹ آزادی ہند کے سلسلہ میں تحریک محمدین کی خدمات بیان کر سکے

Tarjumat-ul-Quran / Civics-II

TTQ-111 / Civic-111;

T	P	C
1	0	1

Total Contact Hours:

Theory: 32

Practical: 0

Note: Syllabi for this subject would be as per BISEs/General education, developed by Punjab Curriculum TextBook Board (PCTB)

Total contact hours

Theory	64	T	P	C
Practical	0	2	0	2

LEARNING OUTCOMES At the end of the course, the students will be equipped with cognitive skill to enable them to present facts in a systematic and logical manner to meet the language demands of dynamic field of commerce and industry for functional day- to-day use and will inculcate skills of reading, writing and comprehension.

COURSE CONTENTS

ENGLISH PAPER "A"

- | | | |
|----------|--|-----------------|
| 1 | PROSE/TEXT | 16 hours |
| | 1.1 First eight essays of Intermediate English Book-II | |
| 2 | CLOZE TEST | 4 hours |
| | 2.1 A passage comprising 50-100 words will be selected from the text. Every 11th word or any word for that matter will be omitted. The number of missing word will range between 5-10. The chosen word may or may not be the one used in the text, but it should be an appropriate word. | |

ENGLISH PAPER "B"

- | | | |
|-----------|---|-----------------|
| 3 | GRAMMAR | 26 hours |
| | 3.1 Sentence Structure. | |
| | 3.2 Tenses. | |
| | 3.3 Parts of speech. | |
| | 3.4 Punctuation. | |
| | 3.5 Change of Narration. | |
| | 3.6 One word for several | |
| | 3.7 Words often confused | |
| 4. | COMPOSITION | 8 hours |
| | 4.1 Letters/Messages | |
| | 4.2 Job application letter | |
| | 4.3 For character certificate/for grant of scholarship | |
| | 4.4 Telegrams, Cablegrams and Radiograms, Telexes, Facsimiles | |
| | 4.5 Essay writing | |
| | 4.6 Technical Education, Science and Our life, Computers, Environmental Pollution, Duties of a Student. | |
| 5. | TRANSLATION | 4 hours |
| | 5.1 Translation from Urdu into English. | 6 hours |
| | For Foreign Students: A paragraph or a dialogue. | |

RECOMMENDED BOOKS

1. Technical English developed by Mr. Zia Sarwar, Mr. Habib-ur –Rehman,
Evaluated by Mr.Zafar Iqbal Khokhar, Mr. Zahid Zahoor, Vol - I, National Book
Foundation

INSTRUCTIONAL OBJECTIVES

PAPER-A

1. **DEMONSTRATE BETTER READING, COMPREHENSION AND VOCABULARY**

- 1.1 Manipulate, skimming and scanning of the text.
- 1.2 Identify new ideas.
- 1.3 Reproduce facts, characters in own words
- 1.4 Write summary of stories

2. **UNDERSTAND FACTS OF THE TEXT**

- 2.1 Rewrite words to fill in the blanks recalling the text.
- 2.2 Use own words to fill in the blanks.

PAPER-B

3. **APPLY THE RULES OF GRAMMAR IN WRITING AND SPEAKING**

- 3.1 Use rules of grammar to construct meaningful sentences containing a subject and a predicate.
- 3.2 State classification of time, i.e present, past and future and use verb tense correctly in different forms to denote relevant time.
- 3.3 Identify function words and content words.
- 3.4 Use marks of punctuation to make sense clear.
- 3.5 Relate what a person says in direct and indirect forms.
- 3.6 Compose his writings.
- 3.7 Distinguish between confusing words.

4. **APPLY THE CONCEPTS OF COMPOSITION WRITING TO PRACTICAL SITUATIONS**

- 4.1 Use concept to construct applications for employment, for character certificate, for grant of scholarship.
- 4.2 Define and write telegrams, cablegrams and radiograms, telexes, facsimiles
- 4.3 Describe steps of a good composition writing.
- 4.4 Describe features of a good composition.
- 4.5 Describe methods of composition writing
- 4.6 Use these concepts to organize facts and describe them systematically in practical situation.

5. **APPLIES RULES OF TRANSLATION**

- 5.1 Describe confusion.
- 5.2 Describe rules of translation.
- 5.3 Use rules of translation from Urdu to English in simple paragraph and sentences.

Math-113 APPLIED MATHEMATICS - I**Total contact hours**

96

T**P****C**

Theory

3

0

3

Pre-requisite: Must have completed a course of Elective Mathematics at Matric level.

LEARNING OUTCOMES: After completing the course the students will be able to

1. Solve problems of Algebra, Trigonometry, vectors. Menstruation, Matrices and Determinants.
2. Develop skill, mathematical attitudes and logical perception in the use of mathematical instruments as required in the technological fields.
3. Acquire mathematical clarity and insight in the solution of technical problems.

COURSE CONTENTS**1 QUADRATIC EQUATIONS****6 Hrs**

1.1 StandardForm

1.2 Solution

1.3 Nature of roots

1.4 Sum & Productof roots

1.5 Formation

1.6 Problems

2 ARITHMETIC PROGRESSION AND SERIES**3Hrs**

2.1 Sequence

2.2 Series

2.3 nth term

2.4 Sum of the first n terms

2.5 Means

2.6 Problems

3 GEOMETRIC PROGRESSION AND SERIES**3Hrs**

3.1 nth term

3.2 sum of the first n terms

3.3 Means

3.4 Infinite Geometric progression

3.5 Problems

4 BINOMIAL THEOREM**6 Hrs**

4.1 Factorials

4.2 Binomial Expression

4.3 Binomial Co-efficient

4.4 Statement

4.5 The General Term

4.6 The Binomial Series.

4.7 Problems

5	PARTIAL FRACTIONS	6 Hrs
5.1	Introduction	
5.2	Linear Distinct Factors Case I	
5.3	Linear Repeated Factors Case II	
5.4	Quadratic Distinct Factors Case III	
5.5	Quadratic Repeated Factors Case IV	
5.6	Problems	
6	FUNDAMENTALS OF TRIGONOMETRY	6 Hrs
6.1	Angles	
6.2	Quadrants	
6.3	Measurements of Angles	
6.4	Relation between Sexagesimal & circular system	
6.5	Relation between Length of a Circular Arc & the Radian Measure of its central Angle	
6.6	Problems	
7	TRIGONOMETRIC FUNCTIONS AND RATIOS	6 Hrs
7.1	trigonometric functions of any angle	
7.2	Signs of trigonometric Functions	
7.3	Trigonometric Ratios of particular Angles	
7.4	Fundamental Identities	
7.5	Problems	
8	GENERAL IDENTITIES	6 Hrs
8.1	The Fundamental Law	
8.2	Deductions	
8.3	Sum & Difference Formulae	
8.4	Double Angle Identities	
8.5	Half Angle Identities	
8.6	Conversion of sum or difference to products	
8.7	Problems	
9	SOLUTION OF TRIANGLES	6 Hrs
9.1	The law of Sines	
9.2	The law of Cosines	
9.3	Measurement of Heights & Distances	
9.4	Problems	
10	MENSURATION OF SOLIDS	30 Hrs
10.1	Review of regular plane figures and Simpson's Rule	
10.2	Prisms	
10.3	Cylinders	
10.4	Pyramids	
10.5	Cones	
10.6	Frusta	
10.7	Spheres	

11	VECTORS	9 Hrs
11.1	Scalars & Vectors	
11.2	Addition & Subtraction	
11.3	The unit Vectors i, j, k	
11.4	Direction Cosines	
11.5	Scalar or Dot Product	
11.6	Deductions	
11.7	Dot product in terms of orthogonal components	
11.8	Deductions	
11.9	Analytic Expression for $a \times b$.	
11.10	Problems.	
12	MATRICES AND DETERMINANTS	9 Hrs
12.1	Definition of Matrix	
12.2	Rows & Columns	
12.3	Order of a Matrix	
12.4	Algebra of Matrices	
12.5	Determinants	
12.6	Properties of Determinants	
12.7	Solution of Linear Equations	
12.8	Problems	

REFERENCE BOOKS

Applied Mathematics Math-113, by Nasir -ud-Din Mahmood, Sana-ullah Khan, Tahir Hameed, Syed Tanvir Haider, Javed Iqbal, Vol - I, National Book Foundation

INSTRUCTIONAL OBJECTIVES

1 USE DIFFERENT METHODS FOR THE SOLUTION OF QUADRATIC EQUATIONS

- 1.1 Define a standard quadratic equation.
- 1.2 Use methods of factorization and method of completing the square for solving the equations.
- 1.3 Derive quadratic formula.
- 1.4 Write expression for the discriminant
- 1.5 Explain nature of the roots of a quadratic equation.
- 1.6 Calculate sum and product of the roots.
- 1.7 Form a quadratic equation from the given roots.
- 1.8 Solve problems involving quadratic equations.

2 UNDERSTAND APPLY CONCEPT OF ARITHMETIC PROGRESSION AND SERIES

- 2.1 Define an Arithmetic sequence and a series
- 2.2 Derive formula for the n th term of an A.P.
- 2.3 Explain Arithmetic Mean between two given numbers
- 2.4 Insert n Arithmetic means between two numbers
- 2.5 Derive formulas for summation of an Arithmetic series
- 2.6 Solve problems on Arithmetic Progression and Series

3 UNDERSTAND GEOMETRIC PROGRESSION AND SERIES

- 3.1 Define a geometric sequence and a series.
- 3.2 Derive formula for n th term of a G.P.
- 3.3 Explain geometric mean between two numbers.
- 3.4 Insert n geometric means between two numbers.
- 3.5 Derive a formula for the summation of geometric Series.
- 3.6 Deduce a formula for the summation of an infinite G.P.
- 3.7 Solve problems using these formulas.

4 EXPAND AND EXTRACT ROOTS OF A BINOMIAL

- 4.1 State binomial theorem for positive integral index.
- 4.2 Explain binomial coefficients: $(n,0), (n,1), \dots, (n,r), \dots, (n,n)$
- 4.3 Derive expression for the general term.
- 4.4 Calculate the specified terms.
- 4.5 Expand a binomial of a given index. -
- 4.6 Extract the specified roots
- 4.7 Compute the approximate value to a given decimal place.
- 4.8 Solve problems involving binomials.

5 RESOLVE A SINGLE FRACTION INTO PARTIAL FRACTIONS USING DIFFERENT METHODS.

- 5.1 Define a partial fraction, a proper and an improper fraction.
- 5.2 Explain all the four types of partial fractions.

- 5.3 Set up equivalent partial fractions for each type.
- 5.4 Explain the methods for finding constants involved.
- 5.5 Resolve a single fraction into partial fractions.
- 5.6 Solve problems involving all the four types.

6 UNDERSTANDING SYSTEMS OF MEASUREMENT OF ANGLES.

- 6.1 Define angles and the related terms.
- 6.2 Illustrate the generation of angle.
- 6.3 Explain sexagesimal and circular systems for the measurement of angles
- 6.4 Derive the relationship between radian and degree.
- 6.5 Convert radians to degrees and vice versa.
- 6.6 Derive a formula for the circular measure of a central angle.
- 6.7 Use this formula for solving problems.

7 APPLY BASIC CONCEPTS AND PRINCIPLES OF TRIGONOMETRIC FUNCTIONS

- 7.1 Define the basic trigonometric functions/ratios of an angle as ratios of the sides of a right triangle.
- 7.2 Derive fundamental identities.
- 7.3 Find trigonometric ratios of particular angles.
- 7.4 Draw the graph of trigonometric functions.
- 7.5 Solve problems involving trigonometric functions.

8 USE TRIGONOMETRIC IDENTITIES IN SOLVING TECHNOLOGICAL PROBLEMS

- 8.1 List fundamental identities
- 8.2 Prove the fundamental law
- 8.3 Deduce important results
- 8.4 Derive-sum and difference formulas
- 8.5 Establish half angle, double angle & triple angle formulas
- 8.6 Convert sum or difference into product & vice versa
- 8.7 Solve problems

9 USE CONCEPTS, PROPERTIES AND LAWS OF TRIGONOMETRIC FUNCTIONS FOR SOLVING TRIANGLES

- 9.1 Define angle of elevation and angle of depression.
- 9.2 Prove the law of sines and the law of cosines.
- 9.3 Explain elements of a triangle.
- 9.4 Solve triangles and the problems involving heights and distances.

10 USE PRINCIPLES OF MENSTRUATION IN FINDING SURFACES, VOLUME AND WEIGHTS OF SOLIDS.

- 10.1 Define menstruation of plane and solid figures
- 10.2 List formulas for perimeters & areas of plane figure.
- 10.3 Define pyramid and cone.
- 10.4 Define frusta of pyramid and cone.
- 10.5 Define a sphere and a shell.
- 10.6 Calculate the total surface and volume of each type of solid.

- 10.7 Compute weight of solids.
- 10.8 Solve problems of these solids.

11. USE THE CONCEPT AND PRINCIPLES OF VECTORS IN SOLVING TECHNOLOGICAL PROBLEMS.

- 11.1 Define vector quantity.
- 11.2 Explain addition and subtraction of vector
- 11.3 Illustrate unit vectors $\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$.
- 11.4 Express a vector in the component form.
- 11.5 Explain magnitude, unit vector, direction cosines of a vector.
- 11.6 Derive analytic expression for dot product and cross product of two vector.
- 11.7 Deduce conditions of perpendicularity and parallelism of two vectors.
- 11.8 Solve problems

12. USE THE CONCEPT OF MATRICES & DETERMINANTS IN SOLVING TECHNOLOGICAL PROBLEMS

- 12.1 Define a matrix and a determinant.
- 12.2 List types of matrices.
- 12.3 Define transpose, adjoint and inverse of a matrix.
- 12.4 State properties of determinants.
- 12.5 Explain basic concepts.
- 12.6 Explain algebra of matrices.
- 12.7 Solve linear equation by matrices.
- 12.8 Explain the solution of a determinant.
- 12.9 Use Crammer's Rule for solving linear equations

Phy-122: APPLIED PHYSICS

T	P	C
1	3	2

Total Contact Hours

Theory: 32

Practical 96

LEARNING OUTCOMES : The students will be able to understand the fundamental principles and concept of physics, use these to solve problems in Practical situation/technological courses and understand concepts to learn advance physics/technical courses.

COURSE CONTENTS

- 1. MEASUREMENTS** 2Hours
 - 1.1 Fundamental units and derived units
 - 1.2 Systems of measurement and S.I. units
 - 1.3 Concept of dimensions, dimensional formula
 - 1.4 Conversion from one system to another
 - 1.5 Significant figures
- 2. SCALARS AND VECTORS** 3 Hours
 - 2.1 Revision of head to tail rule
 - 2.2 Laws of parallelogram, triangle and polygon of forces
 - 2.3 Resolution of a vector
 - 2.4 Addition of vectors by rectangular components
 - 2.5 Multiplication of two vectors, dot product and cross product
- 3. MOTION** 4 Hours
 - 1.1 Review of laws and equations of motion
 - 1.2 Law of conservation of momentum
 - 1.3 Angular motion
 - 1.4 Relation between linear and angular motion
 - 1.5 Centripetal acceleration and force
 - 1.6 Equations of angular motion
- 4. TORQUE, EQUILIBRIUM AND ROTATIONAL INETRTIA** 4Hours
 - 4.1 Torque
 - 4.2 Centre of gravity and centre of mass
 - 4.3 Equilibrium and its conditions
 - 4.4 Torque and angular acceleration
 - 4.5 Rotational inertia

- 5. WAVE MOTION** **4Hours**
- 5.1 Review Hooke's law of elasticity
 - 5.2 Motion under an elastic restoring force
 - 5.3 Characteristics of simple harmonic motion
 - 5.4 S.H.M. and circular motion
 - 5.5 Simple pendulum
 - 5.6 Wave form of S.M.H.
 - 5.7 Resonance
 - 5.8 Transverse vibration of a stretched string
- 6. SOUND** **5Hours**
- 6.1 Longitudinal waves
 - 6.2 Intensity, loudness, pitch and quality of sound
 - 6.3 Units of Intensity of level and frequency response of ear
 - 6.4 Interference of sound waves silence zones, beats
 - 6.5 Acoustics
 - 6.6 Doppler effect.
- 7. LIGHT** **2Hours**
- 7.1 Review laws of reflection and refraction
 - 7.2 Image formation by mirrors and lenses
 - 7.3 Optical instruments
 - 7.4 Wave theory of light
 - 7.5 Interference, diffraction, polarization of light waves
 - 7.6 Applications of polarization in sunglasses, optical activity and stress analysis
- 8. OPTICAL FIBER** **3Hours**
- 8.1 Optical communication and problems
 - 8.2 Review total internal reflection and critical angle
 - 8.3 Structure of optical fiber
 - 8.4 Fiber material and manufacture
 - 8.5 Optical fiber – uses.
- 9. LASERS** **4Hours**
- 9.1 Corpuscular theory of light
 - 9.2 Emission and absorption of light
 - 9.3 Stimulated absorption and emission of light
 - 9.4 Laser principle
 - 9.5 Structure and working of lasers

- 9.6 Types of lasers with brief description.
- 9.7 Applications (basic concepts)
- 9.8 Material processing
- 9.9 Laser welding
- 9.10 Laser assisted machining
- 9.11 Micro machining
- 9.12 Drilling, scribing and marking
- 9.13 Printing
- 9.14 Lasers in medicines

RECOMMENDED BOOKS

1. Tahir Hussain, Fundamentals of Physics Vol-I and II.
2. Farid Khawaja, Fundamentals of Physics Vol-I and II.
3. Wells and Slusher, Schaum's Series Physics.
4. Nelkon and Oyborn, Advanced Level Practical Physics
5. Mehboob Ilahi Malik and Inam-ul-Haq, Practical Physics
6. Wilson, Lasers – Principles and Applications.
7. M. Aslam Khan and M. Akram Sandhu, Experimental Physics Note Book.

INSTRUCTIONAL OBJECTIVES

- 1. USE CONCEPTS OF MEASUREMENT TO PRACTICAL SITUATIONS AND TECHNOLOGICAL PROBLEMS.**
 - 1.1 Write dimensional formulae for physical quantities
 - 1.2 Derive units using dimensional equations
 - 1.3 Convert a measurement from one system to another
 - 1.4 Use concepts of measurement and Significant figures in problem solving.
- 2. USE CONCEPTS OF SCALARS AND VECTORS IN SOLVING PROBLEMS INVOLVING THESE CONCEPTS.**
 - 2.1 Explain laws of parallelogram, triangle and polygon of forces
 - 2.2 Describe method of resolution of a vector into components
 - 2.3 Describe method of addition of vectors by rectangular components
 - 2.4 Differentiate between dot product and cross product of vectors
 - 2.5 Use the concepts in solving problems involving addition, resolution and multiplication vectors.
- 3. USE THE LAW OF CONSERVATION OF MOMENTUM AND CONCEPTS OF ANGULAR MOTION TO PRACTICAL SITUATIONS.**
 - 3.1 Use law of conservation of momentum to Practical/technological problems.
 - 3.2 Explain relation between linear and angular motion.
 - 3.3 Use concepts and equations of angular motion to solve relevant technological problems.
- 4. USE CONCEPTS OF TORQUE, EQUILIBRIUM AND ROTATIONAL INERTIA TO PRACTICAL SITUATION/PROBLEMS.**
 - 4.1 Explain Torque
 - 4.2 Distinguish between centre of gravity and centre of mass
 - 4.3 Explain rotational equilibrium and its conditions
 - 4.4 Explain Rotational Inertia giving examples
 - 4.5 Use the above concepts in solving technological problems.
- 5. USE CONCEPTS OF WAVE MOTION IN SOLVING RELEVANT PROBLEMS.**
 - 5.1 Explain Hooke's Law of Elasticity
 - 5.2 Derive formula for Motion under an elastic restoring force
 - 5.3 Derive formulae for simple harmonic motion and simple pendulum
 - 5.4 Explain wave form with reference to S.H.M. and circular motion
 - 5.5 Explain Resonance
 - 5.6 Explain transverse vibration of a stretched string
 - 5.7 Use the above concepts and formulae of S.H.M. to solve relevant problems.

- 6. UNDERSTAND CONCEPTS OF SOUND**
 - 6.1 Describe longitudinal wave and its propagation
 - 6.2 Explain the concepts: Intensity, loudness, pitch and quality of sound
 - 6.3 Explain units of Intensity of level and frequency response of ear
 - 6.4 Explain phenomena of silence zones, beats
 - 6.5 Explain Acoustics of buildings
 - 6.6 Explain Doppler effect giving mathematical expressions.
- 7. USE THE CONCEPTS OF GEOMETRICAL OPTICS TO MIRRORS AND LENSES.**
 - 7.1 Explain laws of reflection and refraction
 - 7.2 Use mirror formula to solve problems
 - 7.3 Use the concepts of image formation by mirrors and lenses to describe working of optical instruments, e.g. microscopes, telescopes, camera and sextant.
- 8. UNDERSTAND WAVE THEORY OF LIGHT**
 - 8.1 Explain wave theory of light
 - 8.2 Explain phenomena of interference, diffraction, polarization of light waves
 - 8.3 Describe uses of polarization given in the course contents.
- 9. UNDERSTAND THE STRUCTURE, WORKING AND USES OF OPTICAL FIBER**
 - 9.1 Explain the structure of the Optical Fiber
 - 9.2 Explain its principle of working
 - 9.3 Describe use of optical fiber in industry and medicine
- 10. UNDERSTAND THE STRUCTURE, WORKING, AND USES OF LASERS**
 - 10.1 Explain the stimulated emission of radiation
 - 10.2 Explain the laser principle
 - 10.3 Describe the structure and working of lasers
 - 10.4 Distinguish between types of lasers
 - 10.5 Describe the applications of lasers in the fields mentioned in the course contents.

LIST OF PRACTICALS

96

Hours

1. Draw graphs representing the functions:
 - (a) $y = mx$ for $m = 0, 0.5, 1, 2$
 - (b) $y = x^2$
 - (c) $y = 1/x$
2. Find the volume of a given solid cylinder using vernier callipers.
3. Find the area of cross-section of the given wire using micrometer screw gauge.
4. Prove that force is directly proportional to (a) mass, (b) acceleration, using fletcher's trolley.
5. Verify law of parallelogram of forces using Grave-sands apparatus.
6. Verify law of triangle of forces and Lami's theorem
7. Determine the weight of a given body using
 - (a) Law of parallelogram of forces
 - (b) Law of triangle of forces
 - (c) Lami's theorem
8. Verify law of polygon of forces using Grave-sands apparatus.
9. Locate the position and magnitude of resultant of like parallel forces.
10. Determine the resultant of two unlike parallel forces.
11. Find the weight of a given body using principle of moments.
12. Locate the centre of gravity of regular and irregular shaped bodies.
13. Find Young's Modules of Elasticity of a metallic wire.
14. Verify Hooke's Law using helical spring.
15. Study of frequency of stretched string with length.
16. Study of variation of frequency of stretched string with tension.
17. Study resonance of air column in resonance tube and find velocity of sound.
18. Find the frequency of the given tuning fork using resonance tube.
19. Find velocity of sound in rod by Kundt's tube.
20. Verify rectilinear propagation of light and study shadow formation.
21. Study effect of rotation of plane mirror on reflection.
22. Compare the refractive indices of given glass slabs.
23. Find focal length of concave mirror by locating centre of curvature.
24. Find focal length of concave mirror by object and image method.
25. Find focal length of concave mirror with converging lens.
26. Find refractive index of glass by apparent depth.
27. Find refractive index of glass by spectrometer.
28. Find focal length of converging lens by plane mirror.
29. Find focal length of converging lens by displacement method.
30. Find focal length of diverging lense using converging lens.
31. Find focal length of diverging lens using concave mirror.
32. Find angular magnification of an astronomical telescope.
33. Find angular magnification of a simple microscope (magnification glass)
34. Find angular magnification of a compound microscope.
35. Study working and structure of camera

36. Study working and structure of sextant
37. Compare the different scales of temperature and verify the conversion formula.
38. Determine the specific heat of lead shots.
39. Find the coefficient of linear expansion of a metallic rod.
40. Find the heat of fusion of ice.
41. Find the heat of vaporization.
42. Determine relative humidity using hygrometer.

Total Contact Hours 128

T	P	C
1	3	2

LEARNING OUTCOMES:

1. Understand the significance and role of chemistry in the development of modern technology
2. Become acquainted with the basic principles of chemistry as applied in the study of relevant technology.
3. Know the scientific methods for production, and use of materials of industrial & technological significance.
4. Gains skill for the efficient conduct of Practical in a chemistry lab.

1. INTRODUCTION AND FUNDAMENTAL CONCEPTS 2 Hours

2. ATOMIC STRUCTURE 2 Hours

3. CHEMICAL BOND 2

- Nature of chemical bond
- Electrovalent bond with examples
- Covalent bond (polar and non-polar, sigma & pie bonds with examples)
- Co-ordinate bond with examples

- 4. WATER** **2 Hours**
- Chemical nature and properties
 - Impurities
 - Hardness of water (types, causes and removal)
 - Scales of measuring hardness (degrees clark French, PPM, Mg- per liter)
 - Boiler feed water, scales and treatment
 - Sea water desalination, sewage treatment
- 5. ACIDS, BASES AND SALTS** **2 Hours**
- Definitions with examples
 - Properties, their strength, basicity and acidity
 - Salts and their classification with examples
 - Ph – value and scale
- 6. OXIDATION & REDUCTION** **2 Hours**
- The process, definition and examples
 - Oxidizing and reducing agents
 - Oxides and their classifications
- 7. NUCLEAR CHEMISTRY** **2 Hours**
- Introduction
 - Radioactivity (alpha, beta and gamma rays)
 - Half life process
 - Nuclear reaction and transformation of elements
- 8. CEMENT** **2 Hours**
- Introduction
 - Composition and manufacture
 - Chemistry of setting and hardening
 - Special purpose cements
- 9. GLASS** **2 Hours**
- Composition and raw material
 - Manufacture
 - Varieties and uses

10.	PLASTICS AND POLYMERS	2 Hours
	Introduction and importance	
	Classification	
	Manufacture	
	Properties and uses	
11.	PAINTS, VARNISHES AND DISTEMPER	2 Hours
	Interoduction	
	Constituents	
	Preparation and use	
12.	CORROSION	2 Hours
	Introduction with causes	
	Types of corrosion	
	Rusting of iron	
	Protective measures against corrosion	
13.	REFRACTORY MATERIALS AND ABRASIVE	2 Hours
	Introduction to refractories	
	Classification of refractories	
	Properties and uses	
	Introduction to abrasives	
	Artificial and natural abrasives and their uses	
14.	ALLOYS	2 Hours
	Introduction with need	
	Preparation and properties	
	Some important alloys and their composition	
	Uses	
15.	FUELS AND COMBUSTION	2 Hours
	Introduction of fuels	
	Classification of fuels	
	Combustion	
	Numerical problems of combustion	
16.	LUBRICANTS	1 Hours

Introduction
Classification
Properties of lubricants
Selection of lubricants

17. POLLUTION

1 Hours

The problems and its dangers
Causes of pollution
Remedies to combat the hazards of pollution

INSTRUCTIONAL OBJECTIVES

1. UNDERSTAND THE SCOPE, SIGNIFICANCE AND FUNDAMENTAL ROLE OF THE SUBJECT

- Define chemistry and its important terms
- State the units of measurements in the study of chemistry
- Write chemical formula of common compounds
- Describe types of chemical reactions with examples

2. UNDERSTAND THE STRUCTURE OF ATOMS AND ARRANGEMENT OF SUB ATOMIC PARTICLES IN THE ARCHITECTURE OF ATOMS

- Define atom
- State the periodic law of elements
- Describe the fundamentals sub atomic particles
- Distinguish between atomic no. And mass no. Isotopes and isobars
- Explain the arrangements of electrons in different shells and sub energy levels
- Explain the grouping and placing of elements in the periodic table

3. UNDERSTAND THE NATURE OF CHEMICAL BOND

- Define chemical bond
- Describe the nature of chemical bond
- Differentiate between electrovalent and covalent bonding
- Explain the formation of polar and non polar, sigma and pi-bond with examples
- Describe the nature of coordinate bond with examples

4. UNDERSTAND THE CHEMICAL NATURE OF WATER

- Describe the chemical nature of water with its formula
 - Describe the general impurities present in water
 - Explain the causes and methods to removing hardness of water
 - Express hardness in different units like mg / liter, p.p.m, degrees clark and degrees French
 - Describe the formation and nature of scales in boiler feed water
 - Explain the method for the treatment of scales
 - Explain the sewage treatment and desalination of sea water
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5. UNDERSTAND THE NATURE OF ACIDS, BASES AND SALTS

Define acids, bases and salts with examples

State general properties of acids and bases

Differentiate between acidity and basicity and use the related terms

Define salts, state their classification with examples

Explain p-h value of solution and ph-scale

6. UNDERSTAND THE PROGRESS OF OXIDATION AND REDUCTION

Define oxidation

Explain the oxidation process with examples

Define reduction

Explain reduction process with examples

Define oxidizing and reducing agents and give at least six examples of each

Define oxides

Classify the oxides and give examples

7. UNDERSTAND THE FUNDAMENTALS OF NUCLEAR CHEMISTRY

Define nuclear chemistry and fadio activity

Differentiate between alpha, beta and gama particles

Explain half life process

Explain at least six nuclear reactions resulting in the transformation of some elements

State important uses of isotopes

8. UNDERSTAND THE MANUFACTURE, SETTING AND HARDENING OF CEMENT

Define Portland cement and give its composition

Describe the method of manufacture

Describe the chemistry of setting and hardening of cement

Distinguish between ordinary and special purpose cement

9. UNDERSTAND THE PROCESS OF MANUFACTURE OF GLASS

Define glass

Describe its composition and raw materials

Describe the manufacture of glass

Explain its varieties and uses

10. UNDERSTAND THE NATURE AND IMPORTANCE OF PLASTIC AND POLYMERS

Define plastics and polymers

Explain the mechanism of polymerization

Describe the preparation and uses of some plastic / polymers

11. KNOW THE CHEMISTRY OF PAINTS, VARNISHES AND DISTEMPERS

Define paints, varnishes and distemper

State composition of each

State methods of preparation of each and their uses

12. UNDERSTAND THE PROCESS OF CORROSION WITH ITS CAUSES AND TYPES

Define corrosion

Describe different types of corrosion. State the causes of corrosion

Explain the process of rusting of iron

Describe methods to prevent / control corrosion

13. UNDERSTAND THE NATURE OF REFRACTORY MATERIALS ABRASIVE

Define refractory materials

Classify refractory materials

Describe properties and uses of refractory

Define abrasive

Classify natural and artificial abrasives

Describe uses of abrasives`

14. UNDERSTAND THE NATURE AND IMPORTANCE OF ALLOYS

Define alloy

Describe different methods for the preparation of alloys

Describe important properties of alloys

Enlist some important alloys with their composition, properties and uses

15. UNDERSTAND THE NATURE OF FUELS AND THEIR COMBUSTION

Define fuels

Classify fuels and make distinction of solid, liquid and gaseous fuels

Describe important fuels

Explain combustion

Calculate air quantities in combustion gases

16. UNDERSTAND THE NATURE OF LUBRICANTS

Define a lubricant

Explain the uses of lubricants

Classify lubricants and site examples

State important properties of oils, greases and solid lubricants

State the criteria for the selection of lubricant for particular purpose / job

17. UNDERSTAND THE NATURE OF POLLUTION

Define pollution (air, water, food)

Describe the causes of environmental pollution

Enlist some common pollutants

Explain methods to prevent pollution

Ch-112: APPLIED CHEMISTRY

LIST OF PRACTICALS

96 Hours

On completion of this course, the trainees will be able to;

1. To introduce the common apparatus, glassware and chemical reagents used in the chemistry lab.
2. To purify a chemical substance by crystallization.
3. To separate a mixture of sand and salt.
4. To find the melting point of substance.
5. To find the pH of a solution with pH paper.
6. To separate a mixture of inks by chromatography.
7. To determine the co-efficient of viscosity of benzene with the help of Ostwald's viscometer.
8. To find the surface tension of a liquid with a stalagmometer.
9. To perform electrolysis of water to produce Hydrogen and Oxygen.
10. To determine the chemical equivalent of copper by electrolysis of Cu SO_4 .
11. Determination of Heat of Neutralization of NaOH and HCl .
12. Determination of Heat of Solution of $\text{C}_2\text{H}_5\text{OH}$ and H_2O .
13. Determination of %age of O_2 in air.
14. Determination of %age of N_2 in air.
15. Determination of %age of CO_2 in air.
16. To get introduction with the methods/apparatus of conducting volumetric estimation.
17. To prepare standard solution of a substance.
18. To find the strength of a given alkali solution.
19. To estimate HCO_3^{-1} contents in water.
20. To estimate Cl^{-1} contents in water.
21. To estimate SO_4^{-2} contents in water.
22. To estimate total solids in water.
23. To find out the %age composition of a mixture solution of KNO_3 and KOH volumetrically.
24. To find out the amount of Na_2SO_4 and NaOH in their mixture with titration method.
25. To find the boiling point of Freon-12, or R-134a and Freon-22.
26. To find the density of Freon-12, or R 134a and Freon-22 with the help of sp. gravity bottle.
27. To prepare Ammonia gas in Laboratory and perform its tests.
28. To get introduction with the scheme of analysis of salts for basic radicals.
29. To analyse Ist group radicals (Ag^{+1} , Pb^{+2} , Hg^{+1}).
30. To exercise Practice for detection of Ist group radicals.
31. To detect and confirm II-A group radicals (Hg^{+2} , Pb^{+4} , Cu^{+2} , Bi^{+3} , Cd^{+2})
32. To detect and confirm II-B group radicals (As^{+3} , Sb^{+3} , $\text{Sn}^{+2, +4}$)

RECOMMENDED BOOKS

1. Text Book of Intermediate Chemistry (Part I and II)
 2. Sh. Atta Mohammad, Ilmi Applied Science.
 3. J.N. Reddy, Polytechnic Chemistry, Tata Mc-Graw Hill Co., New Delhi.
 4. Qammar Iqbal, Chemistry for Engineers and Technologists.
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MT-101: TECHNICAL DRAWING

Total contact hours:

Practical 96 Hours

T	P	C
0	3	1

Learning Outcomes: On completion of this course, the trainees will be able to;

1. Apply the different **relevant** knowledge, skills and attitudes in technical sketching and working drawing.
2. Teach the students how to graphically represent the refrigeration and air conditioning systems.
3. Draw visualization, sense of form and proportions of various forms of drawing.
4. Teach the students how to make layout, of ducting, piping etc.

LIST OF PRACTICALS

1. Practice letter strokes and letter guidelines using standard instruments.
 2. Practice composition of lettering (single stroke & double stroke).
 3. Perform freehand and instrument-based lettering practice.
 4. Draw and identify common alphabet of lines used in engineering drawings.
 5. Apply different types of lines in simple drafting exercises
 6. Draw pictorial views of simple objects.
 7. Practice proportion control in pictorial sketching.
 8. Draw pictorial sketches using isometric, oblique, and perspective methods.
 9. Draw principal planes of projection.
 10. Draw projectors and projection lines.
 11. Draw orthographic (multi-view) sketches of simple machine components.
 12. Draw complete multi-view drawings of given objects.
 13. Practice basic dimensioning of multi-view drawings.
 14. Apply dimensioning to holes, arcs, and circles.
 15. Practice angular dimensioning techniques.
 16. Apply notes, specifications, and rules of dimensioning.
 17. Practice dimensioning as per basic ISO & ASME Y14.5 standards.
 18. Perform basic geometrical constructions (lines, angles, polygons).
 19. Draw tangents to circles and geometrical figures.
 20. Construct geometrical features used in mechanical components.
 21. Prepare preliminary design sketches of simple components.
 22. Draw detailed drawings of individual machine parts.
 23. Draw assembly drawings of simple machine elements.
 24. Prepare complete working drawings of machine components.
 25. Draw full and half sectional views of machine components.
 26. Draw removed, broken, offset, and phantom sections.
 27. Apply material symbols in sectional drawings.
 28. Draw isometric views of lines, arcs, and circles.
 29. Draw oblique views of rectangular blocks.
 30. Draw isometric views of mechanical components.
 31. Draw primary auxiliary views (frontal, horizontal, profile).
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32. Measure the true length of lines using auxiliary views.
33. Draw secondary auxiliary views of objects.
34. Identify HVACR symbols, conventions, and legends.
35. Interpret orthographic, isometric, and sectional drawings.
36. Extract dimensions, materials, and tolerances from given drawings.
37. Interpret real-world HVACR drawings (compressors, duct layouts, piping systems).

BOOKS RECOMMENDED.

1. Engineering Drawing. by French & Vierck.
 2. Geometrical Drawing by N.D. Bhatt.
 3. Ist Year Engineering Drawing by A.C. Parkinson.
 4. Engineering Drawing and Design by David A. Madsen & David P. Madsen
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ET-103: APPLIED ELECTRICITY

T	P	C
2	3	3

Total Contact hours

Theory	64 Hours
Practical	96 Hours

LEARNING OUTCOMES: To enable the student to acquire knowledge of basic principles of electricity and magnetism

COURSE CONTENTS.

1. ELECTRICITY FUNDAMENTALS.	3 Hours
1.1 Modern electron theory	
1.2 Concept of free electrons	
1.3 Electric potential	
1.4 Electron flow as current, unit	
1.5 Static electricity	
1.6 Types of currents – AC and DC	
1.7 Voltage, unit	
1.8 Resistance, units	
1.9 Review of Cardio-Pulmonary Resuscitation (CPR)	
2. OHM’S LAW AND TYPES OF CIRCUIT.	7 Hours
2.1 Ohm’s Law	
2.2 Series circuits, characteristics and uses	
2.3 Parallel circuits, characteristics and uses	
2.4 Series-parallel circuits, solution of simple circuit problems.	
2.5 Voltage drop	
2.6 Electric power, equations and units	
2.7 Alternating current cycle, time period, frequency and its unit.	
2.8 Values of AC-instantaneous, rms, peak and their relations	
3. ELECTRIC CIRCUIT FUNDAMENTALS AND ELECT. METERS	4 Hours
3.1 Symbols used in elect. Circuits	
3.2 Measurement of current, voltage and resistance by meters.	
3.3 Measurement of power by wattmeter.	
3.4 Tong tester & its use	
3.5 Use of multimeter	
3.6 Types of elect. materials	
4. APPLICATION OF KIRCHHOFF’S LAW	2 Hours
4.1 Kirchhoff’s current and voltage laws	
4.2 Problem solving.	
5. APPLICATION OF SOLID STATE AND SEMICONDUCTORS	3 Hours
5.1 Semiconductor type materials	
5.2 P type and N type material impurities doping	
5.3 Logic gates symbol, truth table and Boolean expression	
6. MAGNETISM AND ELECTRO MAGNETISM	5 Hours

6.1	Theory of magnetism	
6.2	Properties of magnets, units of flux, flux density	
6.3	Electromagnetism, units of magnetizing force and field strength	
6.4	Magnetic field strength, Ampere-turns	
6.5	Solenoid, uses in HVAC&R systems.	
6.6	Polarity of electromagnetism, Right Hand Rules	
6.7	Electromagnetic induction, Faraday's Laws, Lenz's Law	
6.8	Permeability, Reluctance, their units	
6.9	Motor action between two magnetic fields.	
6.10	Fleming's Left Hand Rule.	
7.	CAPACITORS AND INDUCTORS	5 Hours
7.1	Capacitance, its units and types	
7.2	Combination of capacitors in series and parallel	
7.3	Use of capacitors in HVAC&R electric circuitry systems.	
7.4	Inductance and its unit	
7.5	Back emf	
7.6	Inductive reactance and units	
8.	D.C. GENERATOR	5 Hours
8.1	Electrical generator, basic principles	
8.2	Construction, field, armature, yoke, commutator, brushes etc.	
8.3	EMF equation	
8.4	Types of DC Generators and their uses.	
9.	ELECTRIC MOTOR USED ON REFRIGERATION EQUIPMENT	9 Hours
9.1	Introduction of induction motors	
9.2	Principle of induction motors	
9.3	Basic types of motors.	
9.4	Single phase motors	
	a. Split phase induction motor	
	b. Capacitor start induction motors (CSIR, CSR & PSC motors)	
	c. Repulsion start induction motor	
	d. BLDC (Brushless DC Motor)	
9.5	Three phase motors	
10.	ALTERNATOR	6 Hours
10.1	Principle of alternator	
10.2	Construction of alternator	
10.3	E.M.F. equation of alternator	
10.4	Excitation of alternators	
11.	TRANSFORMERS	4 Hours
11.1	Principle of operation, construction	
11.2	Primary and secondary windings and voltages	
11.3	Step up and step down transformer.	
11.4	Current ratios in each case	
12.	TYPES AND USE OF WIRING	3 Hours
12.1	Cleat wiring.	

- 12.2 Batten wiring.
- 12.3 Conduit wiring
- 12.4 Earthing.

13. TYPES OF WIRE AND CABLES

4 Hours

- 13.1 V.I.R. cables.
- 13.2 P.V.C. cables.
- 13.3 Multi-core cables
- 13.4 Flexible cables.
- 13.5 Lead sheathed cables.
- 13.6 Paper insulated cables.
- 13.7 Varnish cambric cables.
- 13.8 Mineral insulated cables.
- 13.9 Uses of cables.

14. ELECTRICAL ACCESSORIES.

4 Hours

- 14.1 Starters.
- 14.2 Magnetic contactors.
- 14.3 Stabilizer
- 14.4 Circuit breakers.
- 14.5 Time delay relay
- 14.6 Timers.

RECOMMENDED BOOKS

- 1. Althous - Modern Refrigerating and Air conditioning
- 2. B.L. Theraja - Electrical Technology

ET-103: APPLIED ELECTRICITY

INSTRUCTIONAL OBJECTIVES:

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

1. UNDERSTAND THE ELECTRICITY FUNDAMENTALS.

- 1.1 Define electron theory of electricity
- 1.2 Define resistance, current and voltage.
- 1.3 Enlist types of electricity.
- 1.4 Enlist the methods of generation of electricity
- 1.5 Define electrostatic electricity.
- 1.6 State the difference between direct and alternative current.

2. UNDERSTAND THE OHM'S LAW AND COMBINATION OF RESISTANCES

- 2.1 Define ohm's law
- 2.2 Describe series and parallel circuits.
- 2.3 Explain series and parallel circuits (Combined).
- 2.4 Apply ohm's law in series and parallel circuits for simple problem solving.
- 2.5 Determine voltage drop in series, parallel and series- parallel circuits.
- 2.6 Define power losses.
- 2.7 Explain alternating current.
- 2.8 State the values of A.C.
- 2.9 State the relations between different values of AC.
- 2.10 Define frequency, time period & cycle.

3. UNDERSTAND THE FUNDAMENTALS OF ELECTRIC CIRCUITS, ELECTRICAL MATERIALS AND USE OF ELECTRICAL METERS.

- 3.1 State difference between electrical circuits (series & parallel).
- 3.2 Draw symbols used in elect. Circuits.
- 3.3 State the use of volt meter, ampere meter and ohm meter.
- 3.4 State the use of wattmeter.
- 3.5 Make the connections of basic instruments, (Ammeter, Voltmeter & Watt meter).
- 3.6 State the use of tong tester and multimeter.
- 3.7 Define conductor, semi conductor and insulator.

4. UNDERSTAND THE APPLICATION OF KIRCHHOFF'S LAW

- 4.1 Define Kirchhoff's current law.
- 4.2 Define Kirchhoff's voltage law.
- 4.3 Apply Kirchhoff's laws in solving simple problems.

5. UNDERSTAND THE APPLICATION OF SOLID STATE AND SEMICONDUCTORS

- 5.1 Explain semiconductor type materials.
 - 5.2 Explain P type and N type material impurities doping.
 - 5.3 Logic gates symbol, truth table and Boolean expression (AND, OR, NAND, NOR XOR, NXOR, NOT)
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6. UNDERSTAND MAGNETISM AND ELECTROMAGNETISM

- 6.1 State theory of magnetism.
- 6.2 State the properties of magnetism and units of flux, flux density.
- 6.3 Define electromagnetism and units of field strength and magnetizing force.
- 6.4 Define magnetic field strength and amp-turn.
- 6.5 Explain electromagnetic induction and Faraday's Laws.
- 6.6 Explain the working principle of a solenoid and its uses in HVAC&R circuitry systems.
- 6.7 Define permeability & its unit.
- 6.8 Define reluctance and its unit.
- 6.9 Explain motor action between two magnetic fields and Fleming's Left Hand Rule.

7. UNDERSTAND THE APPLICATION OF CAPACITORS AND INDUCTORS IN HVAC&R SYSTEMS.

- 7.1 Define capacitance and its unit.
- 7.2 State formulae for combining capacitors in series and parallel
- 7.3 Explain the types and uses of capacitors in HVAC&R electric circuitry systems.
- 7.4 Define inductance and its unit
- 7.5 Define back emf
- 7.6 Explain the inductive reactance and unit.

8. UNDERSTAND FUNDAMENTALS OF ELECTRICAL GENERATORS.

- 8.1 Explain the working principle of DC Generator
- 8.2 State the construction of a DC Generator
- 8.3 State emf equation
- 8.4 State the types of DC Generators and their uses.
- 8.5 State the use of commutator.

8 UNDERSTAND WORKING OF ELECTRICAL MOTORS USED ON REFRIGERATION EQUIPMENT.

- 8.1 Define induction motors
- 8.2 Explain the principle of induction motors
- 8.3 Enlist and define the two basic types of electric motors
- 8.4 Describe single phase induction motors, their types, rating and uses.
 - a. Split phase induction motor
 - b. Capacitor start induction motors (CSIR, CSR & PSC motors)
 - c. Repulsion start induction motor.
 - d. BLDC (Brushless DC Motor).
- 8.5 Explain 3-phase induction motors and their uses.
- 8.6 Draw circuit diagrams of all AC motors used on refrigeration equipment.

9 UNDERSTAND THE FUNCTION AND CONSTRUCTION OF AN ALTERNATOR

- 9.1 State the principle of an alternator.
 - 9.2 Explain the construction of an alternator.
 - 9.3 Derive the E.M.F. equation of an alternator.
 - 9.4 Explain the efficiency of an alternator.
 - 9.5 State how alternators are excited.
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10. UNDERSTAND THE TRANSFORMER AND ITS APPLICATION

- 10.1 State the principle of transformers.
- 10.2 Enlist the types of transformer.
- 10.3 Explain primary and secondary windings and the relation between their voltages.
- 10.4 State step up and step down transformer.
- 10.5 Explain the current ratios in both types of transformers.

11. UNDERSTAND THE TYPES AND USES OF WIRING SYSTEMS

- 11.1 Enlist the types of wiring.
- 11.2 State cleat wiring method and uses.
- 11.3 State batten wiring method and uses.
- 11.4 State conduit wiring (surface & concealed) method and uses.
- 11.5 State the need of earthing.
- 11.6 State the methods of earthing.

12 UNDERSTAND THE TYPES OF WIRES AND CABLES.

- 12.1 Distinguish between wire and cables.
- 12.2 Explain current and voltage ratings of wires and cables.
- 12.3 Enlist the types of cables.
- 12.4 State properties and uses of V.I.R. cable.
- 12.5 State properties and uses of P.V.C. cable.
- 12.6 State the construction and uses of multicore cables.
- 12.7 State the sizes and ratings of flexible cable.
- 12.8 State the ratings and uses of lead sheathed and paper insulated cables.
- 12.9 Distinguish between varnish cambric cables and mineral insulated cables.
- 12.10 State the current ratings of 1/.044, 3/.029, 3/.036, 7/.029, 7/.036 and 7/.044 cables.

13 UNDERSTAND THE ELECTRICAL ACCESSORIES WHICH ARE COMMONLY USED IN AIR-CONDITIONING INDUSTRY.

- 13.1 State the purpose of starter and its use with electrical motor above 5 H.P.
 - 13.2 Explain the construction of magnetic contactor and its use in single and three phase circuit.
 - 13.3 Explain the function and working principle of circuit breaker.
 - 13.4 Explain the use and function of time relay.
 - 13.5 Explain the use and function of DOL and Star-delta starters.
 - 13.6 Draw circuit diagrams of motors with electric accessories connected with them.
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LIST OF PRACTICALS

Total - 96 Hours

On completion of this course, the trainees will be able to;

1. Make a simple twist joint of P.V.C cable No.1/0.044
 2. Make a married joint of P.V.C cable No 7/0.036 or 7/0.029
 3. Make pigtail joint of P.V.C Cable No 1/0.044.
 4. Make a "tee" joint of P.V.C. Cable No 7/0.036 or 7/0.029
 5. Construct an electrical Test Box.
 6. Wiring three loads (light bulbs) in a series circuit.
 7. Wiring three loads (light bulbs) and a switch in a series circuit.
 8. Wiring two loads (light bulbs) in series using a switch to turn them off and on, keeping a third light in the circuit on continuously.
 9. Wiring three loads (light bulbs) in a parallel circuit.
 10. Wiring three loads (light bulbs) in a parallel circuit and using a single-throw switch to control the circuit.
 11. Wiring three loads (light bulbs) in parallel using a single-pole single-throw switch to turn two light bulbs off and leave one light bulb on all the time.
 12. Wiring a series-parallel circuit with six light bulbs - three lights wired in parallel, and three light bulbs wired in series.
 13. Wiring a series-parallel circuit with a single-pole single-throw switch controlling the total circuit, where three loads (light bulbs) are wired in parallel, and three loads (light bulbs) are wired in series.
 14. Wiring a series-parallel circuit with a single-pole single-throw switch controlling the series circuit, where three loads (light bulbs) are wired in parallel.
 15. Reading electrical meters.
 16. Measuring resistance using Ohm's law.
 17. Measurement of resistance of a given wire with the help of (VOM) voltmeter, ammeter (Method $V=IR$), Ohmmeter and wheat stone bridge.
 18. Using a voltmeter to measure voltage and record voltage drop in a series circuit.
 19. Using a voltmeter to measure voltage and record voltage drop in a parallel circuit.
 20. Using a clamp-on ammeter to measure current in a series circuit.
 21. Using a clamp-on ammeter to measure amperage in a parallel circuit.
 22. Taking an in-line amperage reading with a VOM.
 23. Checking the resistance at a series circuit with an ohmmeter.
 24. Checking the accuracy and calibration of electrical instruments.
 25. Identify the types of electric motors used on Refrigeration equipment.
 26. Draw an electric circuit diagram of a refrigerator with motor, capacitor, relay and overload.
 27. Dismantling of capacitor start induction run motor.
 28. Draw automatic motor control circuit diagram of single phase induction motor with speed-regulator switch.
 29. Calculate the capacity of voltage stabilizer and its function.
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30. Test motor starter.
 31. Test an open type capacitor start electric motor.
 32. Dismantle and assemble a single phase motor.
 33. Assembling of capacitor start induction motor.
 34. Trace the circuits and draw the wiring diagram for a commercial refrigerating system.
 35. Evaluating the condition of a transformer with an ohmmeter.
 36. Evaluating a transformer primary and secondary voltage.
 37. Hooking a step down transformer to a relay contactor.
 38. Checking a relay contactor with a voltmeter.
 39. Checking a relay contactor with a ohmmeter.
 40. Wiring a relay into a circuit.
 41. Using a switching relay to control two loads in a circuit.
 42. Verification of logic gates AND, OR, NAND, NOR, XOR, NXOR, NOT.
 43. Verify current and voltage ratios in transformers.
 44. Problem solving relating to theory topics.
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Comp-182 ICT Fundamentals

Total Contact Hours:

Theory	32	T	P	C
Practical	96	1	3	2

Learning Outcomes:

After this course the student will be able to:

- Demonstrate foundational knowledge of computer systems, including hardware components, software types, and the fundamentals of data representation and storage.
- Effectively utilize operating systems, particularly Windows, including installation, configuration, and basic troubleshooting.
- Proficiently use core Microsoft Office applications (Word, Excel, and PowerPoint) for document creation, data analysis, and presentations.
- Understand fundamental internet concepts, including web browsing, email communication, basic online safety and security practices, and the ethical and responsible use of generative AI tools.

Course Contents:

1. INTRODUCTION TO COMPUTER

2 Hours

- 1.1. Introduction to computer system
- 1.2. Understanding BIT, Byte, RAM & ROM
- 1.3. Input & Output devices
- 1.4. Secondary storage devices
- 1.5. Processor Types
- 1.6. Types of Software
- 1.7. Printers, scanners and other peripheral devices interfacing
- 1.8. Applications in Engineering, Education & Business

2. OPERATING SYSTEMS

5 Hours

- 2.1 Introduction to Windows
- 2.2 How to install Drivers & Windows
- 2.3 Loading & Shut down process
- 2.4 Introduction to Desktop items (Creation of Icons, Shortcut, Folder & modify Taskbar)
- 2.5 Desktop properties
- 2.6 Use of Control Panel
- 2.7 Introduction to other Operating Systems like LINUX, UNIX and macOS

3. MS-OFFICE (MS-WORD latest Version)

4 Hour

- 3.1 Introduction to MS-Office
 - 3.2 Introduction to MS-Word & its Interface
 - 3.3 Creating, Editing, Formatting, Saving & Opening a document
 - 3.4 Page setup (Set the Margins & Paper)
 - 3.5 Spell Check & Grammar
 - 3.6 Paragraph Alignment
 - 3.7 Inserting Page numbers, Symbols, Text box & Picture in the document
 - 3.8 Use the different Format menu drop down commands
 - 3.9 Insert the Table and it's Editing
 - 3.10 Printing the document
 - 3.11 Saving a document file as PDF format
 - 3.12 Mail Merge using MS Word
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- 4. MS-OFFICE (MS-EXCEL latest Version) 5 Hours**
- 4.1 Introduction to MS-Excel & its Interface
 - 4.2 Entering data & apply formulas in worksheet
 - 4.3 Vlookup, Hlookup, Xlookup and Pivot Tables
 - 4.4 Editing & Formatting the Cells, Row & Column
 - 4.5 Insert Graphs in sheet
 - 4.6 Page setup, Print Preview & Printing
- 5. MS-OFFICE (MS-POWER POINT latest Version) 4 Hours**
- 5.1 Introduction to MS Power Point
 - 5.2 Creating a presentation
 - 5.3 Editing & formatting a text box
 - 5.4 Adding pictures & colours to a slide
 - 5.5 Making Slideshow
 - 5.6 Adding Animations and Transitions
- 6. INTERNET & E-MAIL 4 Hours**
- 6.1 Introduction to Internet & browser window
 - 6.2 Web Browsing
 - 6.3 Email Basics
 - 6.4 Email Management
 - 6.5 Uploading and downloading file(s) and software(s)
 - 6.6 SEO and digital marketing using social media platforms.
 - 6.7 Network Types
- 7. INTRODUCTION TO PRODUCTIVITY TOOLS 4 Hours**
- 7.1 Google Workspace
 - 7.2 Video Conferencing & Collaboration
 - 7.3 Introduction to Canva
- 8. EMERGING TECHNOLOGIES AND THE USE OF GENERATIVE AI TOOLS 4 Hours**
- 8.1 Introduction to Artificial Intelligence (AI) and Machine Learning (ML)
 - 8.2 Generative AI Tools like ChatGPT, Gemini, CoPilot, DALL·E and others.
 - 8.3 Applications of LLM tools like ChatGPT and Similar Tools
 - 8.4 Ethical Considerations and Responsible AI

REFERENCE BOOKS:

1. The Microsoft Office 365 Bible by Max Clark, 2022
 2. Microsoft Excel 365 Bible by Michael Alexander, 2022
 3. Microsoft PowerPoint 365 Bible by Faithe Wempen
 4. Generative AI - The Future of Everything by Sharad Gandhi and Christian Ehl 2023
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Instructional Objectives:

1. INTRODUCTION TO COMPUTER

1.1. Introduction to Computer System

- 1.1.1. History of Computing
- 1.1.2. Basic Components of a Computer System (CPU, Memory, Input/Output, Storage)
- 1.1.3. Computer Architecture
- 1.1.4. Types of Computers (Supercomputers, Mainframes, Servers, Workstations, Personal Computers, Embedded Systems)

1.2. Understanding BIT, Byte, RAM & ROM

- 1.2.1. Binary Number System (Bits, Bytes, and their representation)
- 1.2.2. Memory Units (Kilobytes, Megabytes, Gigabytes, Terabytes, Petabytes)
- 1.2.3. Types of RAM (DRAM, SRAM, their characteristics and applications)
- 1.2.4. Types of ROM (PROM, EPROM, EEPROM, Flash Memory)
- 1.2.5. Cache Memory (Levels of Cache, its role in improving performance)

1.3. Input & Output Devices

- 1.3.1. Input Devices (Keyboard, Mouse, Touchscreen, Microphone, Scanner, Webcam, Joystick, Gamepad)
- 1.3.2. Output Devices (Monitor, Printer, Speaker, Projector, Headphone, Haptic Devices)

1.4. Secondary Storage Devices

- 1.4.1. Magnetic Storage (Hard Disk Drives - HDDs, their working and types)
- 1.4.2. Solid-State Storage (SSDs, Flash Drives, their advantages over HDDs)
- 1.4.3. Optical Storage (CDs, DVDs, Blu-ray, their capacity and limitations)
- 1.4.4. Cloud Storage (Cloud Service Providers, Cloud Storage Models, Advantages and Disadvantages)

1.5. Processor Types

- 1.5.1. Central Processing Unit (CPU) - Core Concept and Function
- 1.5.2. Types of CPUs (x86, ARM, RISC, CISC)
- 1.5.3. Multi-core Processors and their Benefits
- 1.5.4. Graphics Processing Units (GPUs) and their Role

1.6. Types of Software

- 1.6.1. System Software (Operating Systems - Windows, macOS, Linux, their functions)
- 1.6.2. Utility Software (Antivirus, Disk Defragmenters, Backup Software)
- 1.6.3. Application Software (Word Processors, Spreadsheets, Presentation Software, Databases, Multimedia Software, Games)
- 1.6.4. Open-Source vs. Proprietary Software

1.7. Printers, scanners and other peripheral devices interfacing

- 1.7.1. Printer Types (Inkjet, Laser, 3D Printers)
- 1.7.2. Scanner Types (Flatbed, Sheet-fed, Handheld)
- 1.7.3. Other Peripherals (Webcams, Microphones, Speakers, External Hard Drives)
- 1.7.4. Device Drivers and their Importance
- 1.7.5. Connecting Peripherals (USB, Bluetooth, Wi-Fi)

1.8. Applications in Engineering, Education & Business

- 1.8.1. Engineering Applications (CAD/CAM, Simulation Software)
- 1.8.2. Educational Applications and Software
- 1.8.3. Business Applications (CRM, ERP, E-commerce)

2. UNDERSTAND MS-WINDOWS (Latest Version)

2.1. Introduction to Windows

- 2.1.1. Different Windows Versions (Windows XP, 7, 8, 10, 11)
- 2.1.2. Key Features of the Windows Operating System (User Interface, Multitasking, File System, Security)

2.2. How to install Drivers& Windows

- 2.2.1. Hardware Drivers and their Importance
- 2.2.2. Methods of Installing Drivers (Manual, Automatic, Windows Update)
- 2.2.3. Troubleshooting Driver Issues
- 2.2.4. Installation of Windows

2.3. Loading & Shut down process

- 2.3.1. Boot Process
- 2.3.2. Shutdown Process
- 2.3.3. Safe Mode and its Uses

2.4. Introduction to Desktop items (Creation of Icons, Shortcut, Folder & modify Taskbar)

- 2.4.1. Creating and Deleting Desktop Icons
- 2.4.2. Creating Shortcuts to Programs and Files
- 2.4.3. Creating and Managing Folders
- 2.4.4. Customizing the Taskbar (Pinning Programs, Show Desktop Button, Taskbar Properties)

2.5. Desktop properties

- 2.5.1. Changing Desktop Background
- 2.5.2. Screen Saver Settings
- 2.5.3. Display Settings (Resolution, Color Depth)
- 2.5.4. Themes and Personalization Options

2.6. Use of Control Panel

- 2.6.1. Overview of the Control Panel
- 2.6.2. Key Control Panel Applets (System, Devices and Printers, Network and Internet, User Accounts)

2.7. Introduction to other Operating Systems like LINUX, UNIX and macOS

- 2.7.1. Introduction to other operating systems
- 2.7.2. Comparison of Windows, Linux, Unix and macOS (Strengths and Weaknesses of each)

3. UNDERSTAND MS-OFFICE (MS-WORD Latest Version)

3.1. Introduction to MS-Office

- 3.1.1. What is MS-Office Suite?
- 3.1.2. Benefits of using MS-Office

3.2. Introduction to MS-Word& its Interface

- 3.2.1. Overview of MS-Word
 - 3.2.2. Word Interface (Ribbon, Quick Access Toolbar, Status Bar, Backstage View)
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3.3. Creating, Editing, Formatting, Saving & Opening a document

- 3.3.1. Creating a New Document
- 3.3.2. Typing and Editing Text (Inserting, Deleting, Cutting, Copying, Pasting)
- 3.3.3. Basic Text Formatting (Font, Font Size, Color, Bold, Italic, Underline)
- 3.3.4. Saving a Document (Save, Save As, File Formats)
- 3.3.5. Opening Existing Documents

3.4. Page setup (Set the Margins& Paper)

- 3.4.1. Setting Margins (Top, Bottom, Left, Right)
- 3.4.2. Choosing Paper Size (Letter, A4, Legal)
- 3.4.3. Page Orientation (Portrait, Landscape)

3.5. Spell Check & Grammar

- 3.5.1. Using the Spell Check and Grammar Checker
- 3.5.2. AutoCorrect Options

3.6. Paragraph Alignment

- 3.6.1. Left, Right, Center, and Justified Alignment
- 3.6.2. Indentation (First Line, Hanging)
- 3.6.3. Line Spacing

3.7. Inserting Page numbers, Symbols, Text box & Picture in the document

- 3.7.1. Inserting Page Numbers (Header, Footer)
- 3.7.2. Inserting Symbols (Special Characters, Symbols Library)
- 3.7.3. Inserting Text Boxes (Formatting Text within Boxes)
- 3.7.4. Inserting Pictures (From File, Online, Shapes)
- 3.7.5. Image Formatting (Cropping, Resizing, Rotating)

3.8. Use the different Format menu drop down commands (Change Case, Bullet & Numbering and Shading & Border)

- 3.8.1. Change Case (Uppercase, Lowercase, Sentence case, Title Case)
- 3.8.2. Bullet and Numbering Lists (Creating and Formatting Lists)

3.9. Insert the Table and it's Editing

- 3.9.1. Inserting Tables (Rows, Columns)
- 3.9.2. Table Editing (Adding/Deleting Rows/Columns, Merging/Splitting Cells)
- 3.9.3. Formatting Table Cells (Borders, Shading, Alignment)

3.10. Printing the document

- 3.10.1. Print Preview and Page Setup
- 3.10.2. Printing Options (Number of Copies, Print Range)

3.11. Saving a document file as PDF format

- 3.11.1. Understanding PDF Format
- 3.11.2. Saving a Word Document as PDF

3.12. Mail Merge using MS Word

- 3.12.1. Mail Merge Options (Letters, Labels, Envelopes)
 - 3.12.2. Previewing and Printing Merged Documents
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4. UNDERSTAND MS-OFFICE (MS-EXCEL Latest Version)

4.1. Introduction to MS-Excel & its Interface

- 4.1.1. Overview of MS-Excel
- 4.1.2. Excel Interface (Ribbon, Quick Access Toolbar, Formula Bar, Worksheets, Workbooks)
- 4.1.3. Navigating the Excel Worksheet (Cells, Rows, Columns, Sheets)
- 4.1.4. Entering data & apply formulas in worksheet
- 4.1.5. Entering Data (Text, Numbers, Dates)
- 4.1.6. Basic Formulas (SUM, AVERAGE, COUNT, MAX, MIN)
- 4.1.7. Cell References (Relative, Absolute, Mixed)
- 4.1.8. Creating and Applying Formulas (Order of Operations, Functions)

4.2. Vlookup, Hlookup, Xlookup and Pivot Tables

- 4.2.1. VLOOKUP Function (Lookup values in a vertical table)
- 4.2.2. HLOOKUP Function (Lookup values in a horizontal table)
- 4.2.3. XLOOKUP Function (Enhanced lookup function with improved flexibility)
- 4.2.4. Pivot Tables (Creating and Analyzing Data Summaries)
- 4.2.5. Using Pivot Tables to Summarize and Analyze Data

4.3. Editing & Formatting the Cells, Row & Column

- 4.3.1. Editing Cell Contents (Inserting, Deleting, Replacing)
- 4.3.2. Formatting Cells (Number Formats, Font, Color, Alignment)
- 4.3.3. Formatting Rows and Columns (Height, Width, Hiding, Unhiding)
- 4.3.4. Conditional Formatting (Highlighting Cells Based on Conditions)

4.4. Insert Graphs in sheet

- 4.4.1. Types of Charts (Column, Bar, Line, Pie, Area, Scatter)
- 4.4.2. Creating Charts from Data
- 4.4.3. Chart Elements (Titles, Legends, Data Labels)
- 4.4.4. Chart Customization (Formatting Chart Appearance)

4.5. Page setup, Print Preview & Printing

- 4.5.1. Page Setup Options (Margins, Orientation, Scaling)
- 4.5.2. Print Preview (Checking the Layout Before Printing)
- 4.5.3. Printing Worksheets (Selecting Print Area, Setting Print Titles)

5. UNDERSTAND MS-OFFICE (MS-POWER POINT Latest Version)

5.1. Introduction to MS PowerPoint

- 5.1.1. Overview of MS PowerPoint
- 5.1.2. PowerPoint Interface (Ribbon, Quick Access Toolbar, Slide Pane, Notes Pane)
- 5.1.3. Basic Concepts of Presentations (Slides, Layouts, Themes)

5.2. Creating a presentation

- 5.2.1. Creating a New Presentation (Blank Presentation, Templates)
- 5.2.2. Adding Slides (New Slide, Duplicate Slide, Delete Slide)
- 5.2.3. Organizing Slides (Rearranging Slide Order)

5.3. Editing & formatting a text box

- 5.3.1. Adding Text Boxes to Slides
-

- 5.3.2. Formatting Text (Font, Size, Color, Bold, Italic, Underline)
- 5.3.3. Aligning Text within Text Boxes
- 5.3.4. Bullet Points and Numbering
- 5.3.5. Adding pictures & colors to a slide
- 5.3.6. Inserting Pictures (From File, Online, Shapes)
- 5.3.7. Formatting Pictures (Cropping, Resizing, Rotating)
- 5.3.8. Applying Slide Backgrounds (Colors, Gradients, Images)
- 5.3.9. Choosing Slide Layouts and Themes

5.4. Making Slideshow

- 5.4.1. Setting Up Slide Show (Slide Show Settings)
- 5.4.2. Running a Slide Show (Manual and Automatic)

5.5. Adding Animations and Transitions

- 5.5.1. Adding Transitions (Between Slides)
- 5.5.2. Adding Animations (To Objects on Slides)
- 5.5.3. Timing and Effects (Speed, Direction, Trigger)

6. UNDERSTAND INTERNET & E-MAIL

6.1. Introduction to Internet & Web Browsers

- 6.1.1. Basic Concepts (Websites, URLs, Protocols - HTTP, HTTPS)
- 6.1.2. Web Browsers (Chrome, Firefox, Edge, Safari)
- 6.1.3. Browser Interface (Address Bar, Tabs, History, Bookmarks)

6.2. Web Browsing & Online Resources

- 6.2.1. Searching the Web (Search Engines, Keywords, Operators)
- 6.2.2. Saving Web Pages (Bookmarks, Downloads)
- 6.2.3. Printing Web Pages

6.3. Email Basics

- 6.3.1. Creating an Email Account (Gmail, Outlook, Yahoo)
- 6.3.2. Writing and Sending Emails (Compose, Recipients, Subject, Body)
- 6.3.3. Receiving and Reading Emails (Inbox, Sent Mail, Drafts)

6.4. Email Management

- 6.4.1. File Attachments (Sending and Receiving Files)
- 6.4.2. Organizing Emails (Folders, Labels, Filters)
- 6.4.3. Managing Spam (Spam Filters, Unsubscribe Options)
- 6.4.4. Email Security (Phishing, Malware, Strong Passwords)

6.5. Online Data Transfer

- 6.5.1. Uploading and Downloading Files (Cloud Storage, File Transfer Protocols)
- 6.5.2. Downloading and Installing Software

6.6. Online Presence & Digital Marketing

- 6.6.1. Social Media Platforms (Facebook, Twitter, Instagram, LinkedIn)
- 6.6.2. SEO (Search Engine Optimization) Basics
- 6.6.3. Digital Marketing Fundamentals

6.7. Network Types

- 6.7.1. Internet, Intranet, Extranet (Definitions and Differences)

7. INTRODUCTION TO PRODUCTIVITY TOOLS

- 7.1. **Google Workspace**
 - 7.1.1. File Management & Collaboration in Google Drive
 - 7.1.2. Core Applications: Docs, Sheets, Slides, Forms
 - 7.2. **Video Conferencing & Collaboration**
 - 7.2.1. Zoom, Microsoft Teams, Google Meet
 - 7.3. **Canva for Visual Content**
 - 7.3.1. Creating Designs: Presentations, Posters, Social Media Graphics
 - 8. EMERGING TECHNOLOGIES AND THE USE OF GENERATIVE AI TOOLS**
 - 8.1. **Introduction to AI & ML**
 - 8.1.1. Brief Overview of AI & Machine Learning
 - 8.1.2. Types of AI
 - 8.2. **Generative AI Tools**
 - 8.2.1. Defining Generative AI
 - 8.2.2. Key Examples: ChatGPT, DALL-E 2, CoPilot etc.
 - 8.3. **Applications of Generative AI**
 - 8.3.1. Content Creation, Customer Service, Education
 - 8.4. **Ethical Considerations**
 - 8.4.1. Bias, Privacy, Job Market Impact
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1. **Identifying Computer Components**
Identify the basic components of a computer system: CPU, RAM, ROM, input/output devices, and storage.
 2. **Converting Decimal to Binary**
Convert decimal numbers to binary and vice versa.
 3. **Understanding Memory Units**
Identify memory units and their storage capacities (KB, MB, GB, TB).
 4. **Using Input Devices**
Practice using input devices (keyboard, mouse, scanner).
 5. **Using Output Devices**
Practice using output devices (monitor, printer, speakers).
 6. **Exploring Storage Devices**
Compare HDDs, SSDs, and cloud storage in terms of speed and capacity.
 7. **Installing Printers and Scanners**
Connect and install a printer or scanner.
 8. **Exploring Printer Functionality**
Explore the functionality of a printer and practice printing documents.
 9. **Exploring Scanner Functionality**
Explore the functionality of a scanner and practice scanning documents.
 10. **Booting and Shutting Down Windows**
Boot and shut down a Windows system. Use Safe Mode.
 11. **Installing Windows and Drivers**
Install a fresh copy of Windows and drivers for hardware components.
 12. **Customizing the Windows Desktop**
Create shortcuts, folders, and customize the taskbar in Windows.
 13. **Changing Desktop Properties**
Change wallpaper, screensaver, and display resolution in Windows.
 14. **Using the Control Panel**
Explore and modify system settings using the Control Panel in Windows.
 15. **Exploring MS-Word Interface**
Identify menus, ribbons, and toolbar options in MS-Word.
 16. **Creating and Saving Documents**
Create a document, save it, and re-open it with different formats in MS-Word.
 17. **Formatting Text and Pages in MS-Word**
Apply text formatting (font, color, spacing) and page formatting (margins, orientation) in MS-Word.
 18. **Using Spell Check in MS-Word**
Practice using proofreading tools such as spell check and grammar in MS-Word.
 19. **Inserting Page Numbers and Images in MS-Word**
Insert and format page numbers, images, and symbols in documents in MS-Word.
 20. **Exploring MS-Excel Interface**
Identify menus and toolbar options in MS-Excel.
 21. **Creating and Formatting Worksheets in MS-Excel**
Create a new worksheet, format rows and columns, and apply borders in MS-Excel.
 22. **Using Formulas in MS-Excel**
Enter data and apply basic formulas (SUM, AVERAGE, etc.) in MS-Excel.
 23. **Using Advanced Formulas and Pivot Tables**
Enter data and apply advanced formulas (VLOOKUP, HLOOKUP, XLOOKUP etc.) as well as Pivot Tables in MS-Excel.
 24. **Inserting Charts in MS-Excel**
Create and format various types of charts (bar, pie, line) in MS-Excel.
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25. **Page Setup and Printing in MS-Excel**
Set up page margins and print a formatted sheet in MS-Excel.
 26. **Creating a PowerPoint Presentation**
Create a new PowerPoint presentation, add slides, and save the file.
 27. **Inserting Multimedia in PowerPoint**
Insert and format images, videos, and shapes in slides in MS-PowerPoint.
 28. **Browsing and Searching Data**
Use a search engine to find relevant data on a topic.
 29. **Using Email**
Create an email account, send/receive emails, and manage attachments.
 30. **Using Google Workspace**
Practice creating and sharing Google Docs, Sheets, and Slides in Google Workspace.
 31. **Using Online Communication Tools**
Install and explore Zoom, Microsoft Teams, or similar tools for virtual collaboration.
 32. **Using GenAI Tools**
Use and compare the output of different GenAI tools like Gemini, ChatGPT, CoPilot etc.
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HVAC-103: PRINCIPLES OF REFRIGERATION

T	P	C
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Total Contact hours

Theory	64 hours
Practical	96 hours

LEARNING OUTCOMES :The students will be able to: -

- 1 Understand the basic principles of refrigeration.
- 2 State the principles of vapor compression used in refrigeration system.
- 3 Understand refrigeration cycle, its major components, their construction, operation and maintenance

COURSE CONTENTS

- 1 FUNDAMENTALS OF REFRIGERATION.** 4 Hours
 - 1.1 Energy, its types, Heat, its types, Specific heat, units of heat.
 - 1.2 Temperature, Intensity of heat.
 - 1.3 Methods of measuring temperature.
 - 1.4 Laws of thermodynamics.
 - 1.5 Methods of heat transfer.
 - 1.6 Conversion of F.P.S System to SI (metric system)
 - 1.7 Definition of Refrigeration
 - 1.8 Scope of Refrigeration, Types of Refrigeration.
 - 1.9 Role of refrigeration in sustainable development and energy conservation.
 - 1.10 Problem Solving
 - 2 SATURATED AND SUPER-HEATED VAPOURS.** 6 Hours
 - 2.1 Pressure, Dalton's Law of Partial Pressure, Pascal's law, Force & Work
 - 2.2 Saturation temperature, saturated liquid, saturated vapors, sublimation, fusion, critical temperature, vaporization and evaporation, condensation.
 - 2.3 Effect of pressure on saturation temperature and critical temperature.
 - 2.4 Simple vapor compression cycle.
 - 2.5 Condensing and evaporating temperature & pressure.
 - 2.6 Superheated Vapors and Sub-cooling
 - 3 IDEAL GAS LAWS** 6 Hours
 - 3.1 Effect of heat on Solid, Liquid and Gas
 - 3.2 Pressure-temperature-volume relationship of gases.
 - 3.3 Constant pressure process.
 - 3.4 Pressure volume relationship at constant temperature.
 - 3.5 Pressure temperature relationship at constant volume.
 - 3.6 General gas law/equation.
 - 3.7 Problem solving.
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4	REFRIGERANTS	11 Hours
4.1	Refrigerant and their Properties	
4.2	Common refrigerants.	
4.3	Classification of refrigerants and their uses.	
4.4	Study of group I, II, III, refrigerant, of each high and low side pressure.	
4.5	Refrigerant cylinders, colour code for refrigerant cylinders, refrigerants oils.	
4.6	Safe handling of refrigerants and compressed gases.	
4.7	Selection and replacement of refrigerants	
4.8	Introduction to HCFC Refrigerants	
4.9	Suction, Discharge, Condensing & Evaporating Temperature and Pressure of Refrigerants	
4.10	Explain the Kigali Amendment and its impact	
4.11	Identify low-GWP refrigerants such as R-290, R-600a, and CO ₂ , along with their properties.	
5.	COMPRESSORS.	10 Hours
5.1	Purpose of compressor.	
5.2	Principle, Parts & Working of Different Types of compressors:	
5.2.1	Reciprocating compressors.	
5.2.2	Rotary compressors.	
5.2.3	Centrifugal compressors.	
5.2.4	Screw type compressor.	
5.2.5	Scroll compressor	
5.2.6	Introduce inverter compressors and variable speed drives for enhanced energy efficiency.	
6.	CONDENSERS	8 Hours
6.1	Purpose of condenser & receiver	
6.2	Types of condensers, their construction and working.	
6.3	Comparison between air-cooled and water-cooled condensers	
6.4	Purpose of cooling tower and spray ponds.	
7.	REFRIGERANT CONTROL	8 Hours
7.1	Purpose of refrigerant control & its types.	
7.2	Automatic expansion valve & its working principle.	
7.3	Thermostatic expansion valve & its working principle.	
7.4	Capillary tube refrigerant control.	
7.5	Low side & High side pressure float valve and their working principle	
7.6	Hand Expansion valve.	
8.	EVAPORATORS	6 Hours
8.1	Purpose of evaporator & its types	
8.2	Flooded and dry expansion evaporators.	
8.3	Frosting, non-frosting and defrosting evaporators.	
8.4	Natural and forced convection evaporators.	
8.5	Logarithmic Mean Temperature Difference (LMTD)	
9.	MOTOR CONTROLS	5 Hours
9.1	Purpose and types of motor controls.	
9.2	Thermostatic motor controls.	
9.2.1	Range and differential adjustment.	

- 9.3 Low pressure motor control.
- 9.4 High pressure motor control.
- 9.5 Over-Load
- 9.6 Capacitors
- 9.7 Relay and its types.
- 9.8 Capacitors
- 9.9 Relay and its types.

RECOMMENDED BOOKS

1. Modern Refrigeration and Air Conditioning by Althouse.
 2. Principles of Refrigeration by R. J. Dossat
 3. ASHRAE Handbook- Fundamental & Equipment Volume.
 4. Refrigeration and Air Conditioning (A text book) by R.S. Khurmi and J.K. Gupta.
 5. Manual prepared by National Institute of Science & Technology (NISTE), Ministry of Education, Government of Pakistan, Islamabad .
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HVAC-103: PRINCIPLES OF REFRIGERATION

INSTRUCTIONAL OBJECTIVES:

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

1. **UNDERSTAND THE FUNDAMENTALS OF REFRIGERATION AND AIR CONDITIONING**
 - 1.1 Define energy & its types.
 - 1.1.1 Differentiate between K.E. and Potential energy.
 - 1.2 Define heat & its types, specific heat & its types, units of heat.
 - 1.3 Define temperature & its measurement, units and conversion
 - 1.4 Explain laws of thermodynamics.
 - 1.5 Explain the methods of heat transfer.
 - 1.6 Explain F.P.S. System, Metric system: and S.I. System and its conversion
 - 1.7 Define refrigeration
 - 1.7.1 Differentiate between refrigeration and air conditioning.
 - 1.8 Explain the types of refrigeration and its scope
 - 1.9 Role of refrigeration in sustainable development and energy conservation.
 - 1.10 Problem Solutions
 2. **UNDERSTAND THE SATURATED AND SUPERHEATED VAPOURS.**
 - 2.1 Define pressure, boiling point, melting point, force, work and their units
 - 2.2 Define saturated liquid, saturated vapor, sublimation & fusion, saturation temperature, vaporization, evaporation and condensation.
 - 2.3 Explain the effect of pressure on saturated temperature and critical temperature.
 - 2.4 Explain simple vapour compression cycle.
 - 2.5 Define condensing and evaporating pressure and temperature
 - 2.5.1 Define suction and discharge temperature of a refrigeration cycle.
 - 2.6 Define superheated vapor and sub-cooling
 3. **UNDERSTAND THE IDEAL GAS LAWS.**
 - 3.1 Explain the effect of heat on solids, liquids and gases.
 - 3.2 Describe pressure-temperature-volume relationship of gases.
 - 3.3 Explain constant pressure process.
 - 3.4 Explain pressure volume relationship at constant temperature.
 - 3.5 Explain pressure temperature relationship at constant volume.
 - 3.6 Derive the general gas equation.
 - 3.7 Solve problems from given data.
 4. **UNDERSTAND THE ROLE OF REFRIGERANTS**
 - 4.1 Define refrigerants
 - 4.2 Explain types of refrigerants
 - 4.3 Classify refrigerants according to application and safety.
 - 4.4 List and Define Group-I, II and III Refrigerants
 - 4.5 List the color code of refrigerant cylinders & their sizes and Describe refrigerant oils.
 - 4.6 State safety measure in handling refrigerants/compressed gases.
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- 4.7 Explain the method of replacing different refrigerants.
 - 4.8 Explain HCFC's Refrigerants.
 - 4.9 Study the suction & discharge temperature and pressure of different refrigerants
 - 4.10 Introduce the Kigali Amendment and its impacts
 - 4.11 Identify low-GWP refrigerants such as R-290, R-600a, and CO₂, along with their properties.
- 5. UNDERSTAND THE WORKING PRINCIPLES AND USE OF COMPRESSORS IN REFRIGERATION & AIR CONDITIONING FIELD**
- 5.1 State the purpose of compressor.
 - 5.2 Explain the types of compressors , construction & working principles
 - 5.2.1 Explain the types and working principle of reciprocating compressor.
 - 5.2.2 Explain the types and working principal of rotary compressor.
 - 5.2.3 Explain the types and working principle of screw type compressor.
 - 5.2.4 Explain the types and working principle of centrifugal compressor.
 - 5.2.5 Explain the construction and working principle of scroll compressor
 - 5.2.6 Introduce inverter compressors and variable speed drives for enhanced energy efficiency.
- 6. UNDERSTAND THE TYPES AND APPLICATION OF CONDENSERS**
- 6.1 Describe the purpose of condenser & receiver.
 - 6.2 Explain the types of condensers & Explain the construction and working of condensers.
 - 6.3 Comparison between air-cooled and water-cooled condenser.
 - 6.4 Explain the working principles of cooling tower and spray ponds
 - 6.5 Briefly discuss microchannel condensers as a modern, energy-efficient technology.
- 7. UNDERSTAND THE CONCEPT AND WORKING PRINCIPLES OF REFRIGERANT CONTROLS**
- 7.1 State the purpose of refrigerant controls (metering devices) & Name the types of refrigerant controls
 - 7.2 Explain the working principle of automatic expansion value
 - 7.3 Explain the working principle of the thermostatic expansion valves
 - 7.4 Explain the working principles of capillary tube
 - 7.5 Explain the working principles of low side & high side float valve
 - 7.6 Explain the working of hand expansion valve
- 8. UNDERSTAND THE BASIC PRINCIPLES AND APPLICATION OF EVAPORATORS**
- 8.1 Explain the purpose of evaporator & Describe the types of evaporators
 - 8.2 Distinguish between flooded and dry expansion evaporators
 - 8.3 Distinguish between frosting and non frosting types of evaporators.
 - 8.4 Explain natural and forced convection evaporators.
 - 8.5 Describe logarithmic mean temperature difference
 - 8.6 Describe the types of evaporator regarding their construction, shape and temperature.
 - 8.7 Describe logarithmic mean temperature difference
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9. KNOW MOTOR CONTROLS

- 9.1 State the purpose & list the types of motor control
 - 9.2 Explain thermostatic motor control
 - 9.2.1 Define range and differential adjustment
 - 9.3 Explain low pressure motor control
 - 9.4 Define high pressure motor control
 - 9.5 State overload
 - 9.6 Define capacitor and its types
 - 9.7 Explain relay and its types
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HVAC-103: PRINCIPLES OF REFRIGERATION

LIST OF PRACTICALS

96 Hours

On completion of this course, the trainees will be able to;

1. Identify and use common refrigeration tools safely and correctly.
 2. Identify refrigeration equipment and describe their applications.
 3. Cut, flare, and swage soft copper tubing using appropriate tools.
 4. Fabricate tubing assemblies by bending, flaring, swaging, and connecting copper tubes using spring and pulley tube benders.
 5. Fabricate or repair a swaged copper tube connection.
 6. Assemble a complete refrigeration piping and tubing system.
 7. Read and operate a manifold gauge set.
 8. Measure system pressures using a manifold gauge set.
 9. Operate compressor suction and discharge service valves.
 10. Service a refrigeration compressor.
 11. Dismantle, assemble, and test an externally driven reciprocating piston compressor.
 12. Fabricate gaskets for refrigeration equipment.
 13. Dismantle, clean, assemble, and test a hermetically sealed reciprocating compressor.
 14. Use analog and digital AVO meters to test:
 - (a) Capacitors
 - (b) Current relays
 - (c) Potential relays
 - (d) Thermal (hot-wire) relays
 - (e) Solid-state (electronic) relays
 - (f) Overload protectors
 15. Test a compressor for open, short, and ground faults.
 16. Test a fan motor for open, short, and ground faults.
 17. Test a compressor using the direct connection method.
 18. Identify the electrical terminals of a hermetically sealed compressor.
 19. Demonstrate the refrigeration cycle using a refrigeration system trainer.
 20. Replace a relay and overload protector.
 21. Test and calibrate a cooling thermostat.
 22. Connect and test a compressor with a capacitor, relay, and overload protector, and verify its operation.
 23. Measure and record system operating temperatures at designated locations.
 24. Operate and evaluate inverter-based refrigerators and split-type freezer systems.
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SAFETY IN HVAC&R SYSTEMS

HVAC-111

Total Contact Hours

Theory: 32 Hours

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LEARNING OUTCOMES

1. Make it habitual for the trainees to apply for safety Practices required at the workplaces in HVAC&R industry.

COURSE CONTENTS

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|--|-----------------|
| 1. GENERAL SAFETY APPLICATIONS | 12 Hours |
| 1.1 Personal safety. | |
| 1.2 Equipment safety | |
| 1.2.1 Electrical | |
| 1.2.2 Mechanical | |
| 1.3 Safety while using Refrigerant, other gases and accessories | |
| 1.3.1 Exposure to refrigerants. | |
| 1.3.2 Refrigerant containers. | |
| 1.3.3 Other pressurized gas hazards
(Nitrogen, Oxygen, Acetylene, & Liquid Petroleum) | |
| 1.4 Safety while using gas and oil heating equipment. | |
| 1.4.1 Gas leaks | |
| 1.4.2 Oil leaks | |
| 1.4.3 Other gas and oil heating precautions. | |
| 1.5 Safety while using tools | |
| 1.5.1 Power tools | |
| 1.5.2 Ladders and scaffolding | |
| 1.5.3 Soldering and brazing equipment | |
| 1.5.4 Rigging equipment | |
| 1.6 Weather related safety precautions | |
| 1.6.1 Hot weather precautions | |
| 1.6.2 Cold weather precautions | |
| 1.7 Safety Awareness | |
| 1.7.1 Hazard and communication standard | |
| 1.7.2 Confined spaces | |
| 1.7.3 Hazardous waste management | |
| 1.7.4 Job Safety Analysis (JSA) | |
| 1.7.5 Lockout-Tagout (LOTO) Procedures | |
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| 2. | SAFETY IN REFRIGERATION SYSTEMS | 8 Hours |
| | Safety Practices in; | |
| 2.1 | Use of Refrigeration tools and materials | |
| 2.2 | Compression system and compressors | |
| 2.3 | Refrigerant controls | |
| 2.4 | Refrigerants | |
| 2.5 | Refrigerant recovery/recycling/reclaiming | |
| 2.6 | Domestic refrigerators and freezers | |
| 2.7 | Refrigeration commercial systems | |
| 2.8 | Commercial system applications | |
| 2.9 | Transport refrigeration | |
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| 3. | SAFETY IN ELECTRICAL COMPONENTS | 2 Hours |
| | Safety Practices in using; | |
| 3.1 | Cardio-Pulmonary Resuscitation (CPR) | |
| 3.2 | Electrical magnetic fundamentals | |
| 3.3 | Electric motors | |
| 3.4 | Electric circuits and controls | |
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| 4. | SAFETY IN AIR CONDITIONING SYSTEMS | 8 Hours |
| | Safety Practices in; | |
| 4.1 | Basic heating and air conditioning systems | |
| 4.2 | Commercial systems – Heat load and piping | |
| 4.3 | Absorption systems | |
| 4.4 | Heating and humidification systems | |
| 4.5 | Cooling and dehumidification systems | |
| 4.6 | Air cleaning and distribution. | |
| 4.7 | Air conditioning and heating controls | |
| 4.8 | Air conditioning (heat pumps) systems | |
| 4.9 | Automotive air conditioning | |
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| 5. | SAFETY IN SERVICING AND INSTALLING HVAC&R SYSTEMS | 2 Hours |
| | Safety Practices in; | |
| 1.1 | Servicing and installing small hermetic systems | |
| 1.2 | Servicing and installing commercial systems | |
| 1.3 | Servicing and troubleshooting | |
| 1.4 | Near-miss reporting and documentation. | |

RECOMMENDED BOOK

1. Modern Refrigeration and Airconditioning by Althouse
 2. Teaching-Learning Resource Manual on Safety in HVAC&R system
 3. OSHA 29 CFR 1910 – General Industry Safety and Health standards USA
 4. Saudi ARAMCO Safety Handbook and General Instructions (G1 2.100 series)
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INSTRUCTIONAL OBJECTIVES

On completion of this course, the students will be able to;

1. GENERAL SAFETY APPLICATIONS

- 1.1 Define personal safety
- 1.2 Explain equipment safety
 - 1.2.1 Electrical
 - 1.2.2 Mechanical
- 1.3 **Safety while using** refrigerant, other gases and accessories
 - 1.3.1 Exposure to refrigerants
 - 1.3.2 Refrigerant containers
 - 1.3.3 Other pressurized gas hazards
(Nitrogen, Oxygen, Acetylene, & Liquid Petroleum)
- 1.4 **Safety while using** gas and oil heating equipment.
 - 1.4.1 Gas leaks
 - 1.4.2 Oil leaks
 - 1.4.3 Other gas and oil **heating** precautions
- 1.5 **Safety** precautions in use of different tools
 - 1.5.1 Power tools
 - 1.5.2 Ladders and scaffolding
 - 1.5.3 Soldering and **brazing** equipment
 - 1.5.4 Rigging equipment
- 1.6 **Safety related** weather precautions
 - 1.6.1 Hot weather precautions
 - 1.6.2 Cold weather precautions
- 1.7 General safety awareness
 - 1.7.1 Hazard communication standard
 - 1.7.2 Confined spaces
 - 1.7.3 Hazardous waste management
 - 1.7.4 Introduction to Job Safety Analysis (JSA) and Procedures
 - 1.7.5 Introduction to LOCKOUT-TAGOUT (LOTO) Procedures.

2. UNDERSTAND SAFETY APPLICATIONS IN REFRIGERATION SYSTEMS

Explain safety Practices in;

- 2.1 Refrigeration tools and materials
- 2.2 Compression system and compressors
- 2.3 Refrigerant controls
- 2.4 Refrigerants
- 2.5 Refrigerant recovery/recycling/reclaiming
- 2.6 Domestic refrigerators and freezers
- 2.7 Refrigeration commercial systems
- 2.8 Commercial system applications
- 2.9 Transport refrigeration

3. UNDERSTAND SAFETY APPLICATIONS IN ELECTRICAL COMPONENTS

Explain safety Practices in;

- 3.1 Electrical magnetic fundamentals
 - 3.2 Electric motors
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3.3 Electric circuits and controls

4. UNDERSTAND SAFETY APPLICATIONS IN AIR CONDITIONING SYSTEMS

Explain safety Practices in;

- 4.1 Basic heating and air conditioning systems
- 4.2 Commercial systems – Heat load and piping
- 4.3 Absorption systems
- 4.4 Heating and humidification systems
- 4.5 Cooling and dehumidification systems
- 4.6 Air cleaning and distribution.
- 4.7 Air conditioning and heating controls
- 4.8 Air conditioning (heat pumps) systems
- 4.9 Automotive air conditioning

5. UNDERSTAND SAFETY APPLICATIONS IN SERVICING AND INSTALLING HVAC&R SYSTEMS

Explain safety Practices in;

- 5.1 Servicing and installing small hermetic systems
 - 5.2 Servicing and installing commercial systems
 - 5.3 Servicing and troubleshooting
 - 5.4 Near-miss reporting and documentation practices to prevent future incidents.
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HVAC-122: WORKSHOP PRACTICE-I

	T	P	C
Total Contact Hours	0	6	2

Practical: 192

a- Metal Shop

b- Machine/Welding Shop

Learning Outcomes:

- i) Use of basic hand tools and their proper implementation in HVAC&R Technology.
- ii) Use of tools and equipment of sheet metal workshop, machine shop and welding shop.

HVAC-122 WORKSHOP PRACTICE –I

LIST OF PRACTICALS

On completion of this course, the trainees will be able to;

A – METAL SHOP

(Total: 96 Hours)

1. Demonstrate safe working practices in a metal workshop.
2. Measure dimensions using a micrometer and Vernier caliper.
3. Fabricate a riveted seam joint.
4. Fabricate soldered and brazed copper tube joints.
5. Assemble copper tubing and pipe fittings, including taps, cocks, and valves.
6. Assemble a complete copper tubing system using appropriate pipe fittings.
7. Cut copper tubing using a tube cutter.
8. Produce internal and external threads using taps and dies.
9. Assemble a complete galvanized iron (G.I.) piping system using standard pipe fittings.
10. Lay out a square duct for fabrication.
11. Lay out a round duct for fabrication.
12. Cut sheet metal using hand snips.
13. Fabricate a grooved seam by hand.
14. Fabricate single- and double-hemmed edges for seam joints.
15. Fabricate a rectangular duct using a Pittsburgh seam.
16. Fabricate a duct with double-seam corners.
17. Fabricate a two-way duct.
18. Fabricate an ice tray from sheet metal.

B- MACHINE SHOP/WELDING SHOP

(Total: 96 Hours)

1. Demonstrate safe working practices in a machine and welding workshop.
 2. Perform facing, centering, turning, and knurling operations on a lathe machine.
 3. Perform turning, drilling, and thread-cutting operations on a lathe machine.
 4. Identify and demonstrate the components and operation of a welding unit.
-

5. Adjust and operate different types of welding flames.
 6. Fabricate lap, butt, and flange joints using 1/16-inch mild steel sheet.
 7. Demonstrate gas welding, soldering, and brazing techniques.
 8. Fabricate soldered copper tube joints.
 9. Fabricate brazed copper tube joints.
 10. Perform welding and brazing operations in accordance with standard procedures.
 11. Perform soldering and brazing operations using appropriate tools and techniques.
 12. Fabricate a brazed copper tube joint using a brass filler rod and a blow lamp.
 13. Fabricate an arc-welded pipe joint.
 14. Repair a hermetically sealed compressor dome using welding techniques.
 15. Fabricate a spot-welded joint using 1/16-inch mild steel sheets.
 16. Repair the sheet metal cabinet of a refrigerator or deep freezer.
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کل وقت 20 گھنٹے:

اسلامیات / مطالعہ پاکستان

نصاب سال دوم

حصہ اول اسلامیات

حصہ دوم مطالعہ پاکستان

موضوعات:

- 1- سورة المؤمنون ایک تا گیارہ آیات کا ترجمہ مع تشریح
- 2- دس منتخب احادیث مع ترجمہ و تشریح
 - () خیر کم من تعلم القرآن و علمہ
 - () لا ایمان لمن لا امانتہ لہ ولا دین لا من لا اعہد لہ
 - () و یا کم والظن ان الظن اکرب الحدیث
 - () من احدث فی امرنا هذا ما لیس منہ فہورد
 - () من حمل علینا السلاح فلیس منا
 - () انا و کافل الیتیم فی الجنہ
 - () لا ضرر و لا ضرار فی السلام
 - () کلکم راع و کلکم مسول عن رعیتہ
- 3- سیرۃ طیبہ
 - () مکی زندگی - ولادت - بعثت - ہجرت
 - () مدنی زندگی - مواخات - میثاق مدینہ - فتح مکہ (سبب و نتائج)
- 4- حضور ﷺ بحیثیت
 - () خطبہ حجۃ الوداع - انسانی حقوق کا اعلامیہ / حقوق انسانی پالیسی 2018
 - () معلم کامل - سربراہ خاندان
- 5- اسلامی معاشرہ

نظام تعلیم اور اس کے مقاصد - عدل و انصاف - امر بالمعروف - نہی عن المنکر - انسانی حقوق کا معاشرتی اور معاشی ترقی میں کردار

جہاد - کسب حلال - مسجد (اہمیت و فضیلت)
- 6- اسلامی ریاست کی تعریف - اسلامی ریاست کی خصوصیات - اسلامی حکومت کے فرائض - اسلامی طرز حکومت -

حقوق آگاہی معلومات تک رسائی

- ملازم پیشہ قوانین کا تحفظ

() حضور ﷺ کی بطور سربراہ بیان کر سکے

حضور ﷺ بحیثیت

() خطبہ حجۃ الوداع۔ انسانی حقوق کا اعلامیہ حقوق انسانی پالیسی 2018 کے بارے جان سکے

اسلامی معاشرہ:

عمومی مقاصد: اسلامی معاشرہ کی خصوصیات سے آگاہی حاصل کر سکے

خصوصی مقاصد:

() اسلامی معاشرہ کا معنی و مفہوم کر سکے

() اسلامی معاشرہ کی امتیازی خصوصیات بیان کر سکے

() اسلامی معاشرہ میں عدل و احسان کی اہمیت بیان کر سکے

() تبلیغ کے لغوی معنی بیان کر سکے

() تبلیغ کی اہمیت اور ضرورت بیان کر سکے

() جہاد کے لفظی و اصطلاحی معنی بیان کر سکے

() جہاد کی اہمیت بیان کر سکے

() جہاد اور قتل میں فرق بیان کر سکے

() جہاد کی مختلف اقسام بیان کر سکے

() لفظ مسجد کی تعریف بیان کر سکے

() مسجد کی سابقہ حیثیت کو بحال کرنے کے بارے میں اقدامات کو مان سکے

() انسانی حقوق کی معاشی اور معاشرتی ترقی میں اہمیت اور کردار بیان کر سکے

اسلامی ریاست:

عمومی مقاصد:

() اسلامی ریاست کی خصوصیات بیان کر سکے

خصوصی مقاصد:

() ریاست کی تعریف بیان کر سکے

() اسلامی ریاست میں طرز حکومت سے آگاہی حاصل کر سکے

() اسلامی ریاست کی خصوصیات بیان کر سکے

- () اسلامی ریاست کے اغراض و مقاصد بیان کر سکے
- () اسلامی ریاست کے قیام کی لیے جدوجہد کر سکے
- () حقوق آگاہی و معلومات تک رسائی کا قانون جان سکے
- () ملازمت پیشہ خواتین کے حقوق کا تحفظ جان سکے اور
- () معاشرے میں خواتین کے حقوق کا تحفظ یقینی بنائے

نصاب مطالعہ پاکستان

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کل وقت 12 گھنٹے

سال دوم
حصہ دوم

موضوعات:

- () دوقومی نظریہ
- () تحریک پاکستان
- () انڈین کانگریس
- () مسلم لیگ
- () تقسیم بنگال
- () بیٹاق لکھنؤ
- () تحریک خلافت
- () سندھو تحریک
- () تجاویز دہلی
- () نہرو رپورٹ
- () قائد اعظم کے چودہ نکات
- () خطبہ آلہ آباد
- () انتخابات 1938 اور انتقال اقتدار
- () قرارداد پاکستان

حصہ دوم
مطالعہ پاکستان

تدریس مقاصد:

تحریک پاکستان:

عمومی مقاصد:

() قیام پاکستان کے اسباب و تحریک کو بیان کر سکے

خصوصی مقاصد:

() قومیت کے مفہوم کو بیان کر سکے

() دو قومی نظریہ کی تعریف و توضیح کر سکے

() دو قومی نظریہ کی اہمیت بیان کر سکے

() ہندوستانی مسلمانوں کی محرومیوں کو بیان کر سکے

() قومی تشخص کو بحال رکھنے کے لیے مسلمانان ہند کی مساعی بیان کر سکے

() آزادی ہند اور قیام پاکستان علامہ اقبال اور قائد اعظم کی مسایام کریں

() قیام پاکستان سے مستقبل اسلامی مملکت کے قیام کے لیے مسلم عوام کی کوششوں کو بیان کر سکے

() مسلم لیگ کے قیام پاکستان کے لیے جدو جہد بیان کر سکے

(غیر مسلم طلباء کے لیے)

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کل وقت 20 گھنٹے

نصاب اخلاقیات

سال دوم

موضوعات:

معاشرتی اقدار بلحاظ ہمسایہ۔ قوم۔ قومی سطح۔ شہری سطح۔ صنعتی اداروں کی سطح۔ ضروریات۔ ورثہ

() حقوق و فرائض

() قوت برداشت

() قوت ارادی

() لگن و جذبہ

() وسیع النظری

() بے غرضی

() انسانی دوستی

() حفاظتی شعور

() پاس آزادی

() کامل آگاہی

() تغیرات کو قبول کرنا

() خود شناسی

() انسانی حقوق کا اعلامیہ / حقوق انسانی پالیسی 2018

() انسانی حقوق کا معاشرتی اور معاشی ترقی میں کردار

() حقوق آگاہی / معلومات تک رسائی۔ ملازم پیشہ خواتین کا تحفظ

نصاب اخلاقیات سال دوم

تدریس مقاصد:

- طالب علم اخلاقیات کی اہمیت و ضرورت سے آگاہ ہو سکے اور بیان کر سکے
خصوصی مقاصد: طالب علم اس قابل ہو کہ
- () موضوعات کا مطلب بیان کر سکے
 - () عملی زندگی سے مثالوں کی نشاندہی کر سکے
 - () اپنی شخصیت اور معاشرے پر موضوعات کے مطابق اثرات پیدا کرنے کے طریقے بیان کر سکے
 - () اعلیٰ اخلاقی اقدار میں سے قوت برداشت، قوت ارادی، لگن و جذبہ، وسیع النظری، بے غرض، انسانی دوستی شعور، پاس آزادی، کامل آگاہی اور خود شناسی کی اہمیت
 - () اخلاقیات سے متصف ہو کر قومی خدمت بہتر طور پر انجام دے سکے
 - () انسانی حقوق کا اعلامیہ، حقوق انسانی کی پالیسی 2018 کے بارے میں جان سکے
 - () انسانی حقوق کا معاشرتی اور معاشی ترقی میں اہمیت اور کردار بیان کر سکے
 - () حقوق آگاہی، معلومات تک رسائی کے قانون کو جان سکے
 - () ملازم پیشہ خواتین کا تحفظ کو اخلاقیات کا حصہ تصور کرے

Tarjumat-ul-Quran / Civics-II

T	P	C
1	0	1

TTQ-211 / Civic-211;

Total Contact Hours:

Theory: 32

Practical: 0

Note: Syllabi for this subject would be as per BISEs/General education, developed by Punjab Curriculum TextBook Board (PCTB)

Math-223: APPLIED MATHEMATICS-II

T	P	C
3	0	3

Total contact hours:

Theory	96
Practical	0

LEARNING OUTCOMES : The students will be able to:

1. Solve problems of Calculus and Analytic Geometry.
2. Develop mathematical skill, attitudes and logical perception in the use of mathematical instruments.
3. Apply principles of Differential Calculus to work out rate measures, velocity, acceleration, maxima & minima values.
4. Use Principles of Integral Calculus to compute areas & volumes.
5. Acquire proficiency in solving technological problems with mathematical clarity and insight.

COURSE CONTENT

- | | |
|--|----------------|
| 1. FUNCTIONS AND LIMITS | 6 Hours |
| 1.1 Constant & Variable Quantities | |
| 1.2 Functions & their classification | |
| 1.3 The concept of Limit | |
| 1.4 Limit of a Function | |
| 1.5 Fundamental Theorems on Limit | |
| 1.6 Some important Limits | |
| 1.7 Problems | |
| 2. DIFFERENTIATION | 6 Hours |
| 2.1 Increments | |
| 2.2 Differential Coefficient or Derivative | |
| 2.3 Differentiation ab-initio or by first Principle | |
| 2.4 Geometrical Interpretation of Differential coefficient | |
| 2.5 Differential Coefficient of X^n , $(ax + b)^n$ | |
| 2.6 Three important rules | |
| 2.7 Problems | |
| 3. DIFFERENTIATION OF ALGEBRAIC FUNCTIONS | 9 Hours |
| 3.1 Explicit Functions | |
| 3.2 Implicit Functions | |
| 3.3 Parametric forms | |
| 3.4 Problems | |
| 4. DIFFERENTIATION OF TRIGONOMETRIC FUNCTIONS | 6 Hours |
| 4.1 Differential Coefficient of $\sin x$, $\cos x$, $\tan x$ from first principle. | |
| 4.2 Differential Coefficient of $\operatorname{Cosec} x$, $\sec x$, $\cot x$ | |
-

4.3	Differentiation of inverse Trigonometric functions.	
4.4	Problems.	
5.	DIFFERENTIATIONS OF LOGARITHMIC & EXPONENTIAL FUNCTIONS	6 Hours
5.1	Differentiation of $\ln x$	
5.2	Differentiation of $\log a^x$	
5.3	Differentiation of a^x	
5.4	Differentiation of e^x	
5.5	Problems	
6.	RATE OF CHANGE OF VARIABLES.	6 Hours
6.1.	Increasing and decreasing functions	
6.2.	Maxima and Minima values	
6.3.	Criteria for maximum & minimum values	
6.4.	Methods of finding maxima & minima	
6.5.	Problems	
7.	INTEGRATION	9 Hours
1.1	Concept	
1.2	Fundamental Formulas	
1.3	Important Rules	
1.4	Problems	
8.	METHODS OF INTEGRATION.	9 Hours
8.1	Integration by substitution	
8.2	Integration by parts	
8.3	Problems	
9.	DEFINITE INTEGRALS	6 Hours
9.1	Properties	
9.2	Application to area	
9.3	Problems	
10.	DIFFERENTIAL EQUATIONS	6 Hours
10.1	Introduction	
10.2	Degree and Order	
10.3	First order differential equation	
10.4	Solution of Problems	
11.	PLANE ANALYTIC GEOMETRY & STRAIGHT LINE	6 Hours
11.1	Coordinate System	
11.2	Distance Formula	
11.3	The Ratio Formula	
11.4	Inclination and slope of a line	
11.5	The slope Formula	
11.6	Problems	

- 12. EQUATIONS OF STRAIGHT LINE** 6 Hours
- 12.1 Some important Forms
 - 12.2 General Form
 - 12.3 Angle Formula
 - 12.4 Parallelism & Perpendicularity
 - 12.5 Problems
- 13. EQUATIONS OF CIRCLE** 6 Hours
- 13.1 Standard form of Equation
 - 13.2 Central form of Equation
 - 13.3 General form of Equation
 - 13.4 Radius & Coordinates of the centre
 - 13.5 Problems
- 14. STATISTICS** 9 Hours
- 14.1 Concept of mean, median and mode
 - 14.2 Standard deviation
 - 14.3 Laws of probability
 - 14.4 Problems

REFERENCE BOOKS

1. Thomas Finny – Calculus and Analytic Geometry.
 2. Ghulam Yasin Minhas – Technical Mathematics Vol-II, Ilmi Kitab Khana, Lahore.
 3. Prof. Riaz Ali Khan – Polytechnic Mathematic Series Vol I & II, Majeed Sons, Faisalabad.
 4. Prof. Sana Ullah Bhatti – Calculus and Analytic Geometry, Punjab Text Book, Lahore.
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INSTRUCTIONAL OBJECTIVES

- 1. USE THE CONCEPT OF FUNCTIONS AND THEIR LIMITS IN SOLVING SIMPLE PROBLEMS**
 - 1.1 Define a function.
 - 1.2 List all type of functions.
 - 1.3 Explain the concept of limit and limit of a function.
 - 1.4 Explain fundamental theorems on limits.
 - 1.5 Derive some important limits.
 - 1.6 Solve problems on limits.
 - 2. UNDERSTAND THE CONCEPT OF DIFFERENTIAL COEFFICIENT**
 - 2.1 Derive mathematical expression for a differential coefficient.
 - 2.2 Explain geometrical interpretation of differential coefficient.
 - 2.3 Differentiate a constant, a constant associated with a variable and the sum of finite number of functions.
 - 2.4 Solve related problems.
 - 3. USE RULES OF DIFFERENTIATION TO SOLVE PROBLEMS OF ALGEBRAIC FUNCTIONS.**
 - 3.1 Differentiate ab-initio x^n and $(ax + b)^n$.
 - 3.2 Derive product, quotient and chain rules.
 - 3.3 Find derivatives of implicit functions and explicit functions.
 - 3.4 Differentiate parameteric forms, functions w.r.t. another function and by rationalization.
 - 3.5 Solve problems using these formulas.
 - 4. USE RULES OF DIFFERENTIATION TO SOLVE PROBLEMS INVOLVING TRIGONOMETRIC FUNCTIONS.**
 - 4.1 Differentiate from first principle $\sin x$, $\cos x$, $\tan x$.
 - 4.2 Derive formula Derivatives of $\sec x$, $\operatorname{cosec} x$, $\cot x$.
 - 4.3 Find differential coefficients of inverse trigonometric functions
 - 4.4 Solve problems based on these formulas.
 - 5. USE RULES OF DIFFERENTIATION TO LOGARITHMIC AND EXPONENTIAL FUNCTIONS.**
 - 5.1 Derive formulas for differential coefficient of Logarithmic and exponential functions.
 - 5.2 Solve problems using these formulas.
 - 6. UNDERSTAND RATE OF CHANGE OF ONE VARIABLE WITH RESPECT TO ANOTHER.**
 - 6.1 Derive formula for velocity, acceleration and slope of a line.
 - 6.2 Define an increasing and a decreasing function, maxima and minima values, point of inflexion.
-

- 6.3 Explain criteria for maxima and minima values of a function.
 - 6.4 Solve problems involving rate of change of variables.
 - 7. USE RULES OF INTEGRATION IN SOLVING RELEVANT PROBLEMS.**
 - 7.1 Explain the concept of integration.
 - 7.2 State basic theorems of integration.
 - 7.3 List some important rules of integration.
 - 7.4 Derive fundamental formulas of integration.
 - 7.5 Solve problems of integration based on these rules/formulas.
 - 8. UNDERSTAND DIFFERENT METHODS OF INTEGRATION**
 - 8.1 List standard formulas of Integration.
 - 8.2 Integrate a function by substitution method.
 - 8.3 Find integrals of the method of integration by parts.
 - 8.4 Solve problems using these methods.
 - 9. UNDERSTAND METHODS OF SOLVING DEFINITE INTEGRALS.**
 - 9.1 Define definite integral.
 - 9.2 List properties of definite integrals.
 - 9.3 Find areas and work done under the curves using definite integrals.
 - 9.4 Solve problems of definite integrals.
 - 10. USE DIFFERENT METHODS OF INTEGRATION TO SOLVE DIFFERENTIAL EQUATIONS**
 - 10.1 Define a differential equation, its degree and order
 - 10.2 Explain method of separation of variables to solve differential equation of first order and first degree.
 - 10.3 Solve differential equations of first order and first degree.
 - 11. UNDERSTAND THE CONCEPT OF PLANE ANALYTIC GEOMETRY.**
 - 11.1 Explain the rectangular coordinate system
 - 11.2 Locate points in different quadrants.
 - 11.3 Derive distance formula.
 - 11.4 Prove ratio formulas.
 - 11.5 Derive Slope Formula.
 - 11.6 Solve problem using these formulas.
 - 12. USE EQUATIONS OF STRAIGHT LINE IN SOLVING PROBLEMS.**
 - 12.1 Define a straight line.
 - 12.2 Write general form of equation of a straight line.
 - 12.3 Derive slope intercept and intercept forms of equations of a straight line.
 - 12.4 Derive expression for angle between two straight lines.
 - 12.5 Derive conditions of perpendicularity and parallelism of two straight lines.
 - 12.6 Solve problems involving these equations/formulas.
 - 13. SOLVE TECHNOLOGICAL PROBLEMS USING EQUATIONS OF CIRCLE.**
 - 13.1 Define a circle.
 - 13.2 Describe standard, central and general forms of the equation of a circle.
 - 13.3 Convert general form to the central form of equation of a circle.
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- 13.4 Derive formula for the radius and the coordinates of the center of a circle from the general form.
- 13.5 Derive equation of the circle passing through three given points.
- 13.6 Solve problems involving these equations.

14. UNDERSTAND THE BASIC CONCEPT OF STATISTICS.

- 14.1 Define mean, median and mode
 - 14.2 Explain standard deviation
 - 14.3 State laws of probability
 - 14.4 Calculate the above mentioned quantities using the proper formula.
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MGM-242: BUSINESS MANAGEMENT AND ACCOUNTING

T	P	C
2	0	2

Total contact hours:

Theory	64
Practical	0

LEARNING OUTCOMES : The course has been designed to enable the students:

1. To understand the policies and programmes of management and proper execution thereof in industrial and commercial set up.
2. To acquaint the students to handle the accounts.
3. To solve problems of business management.

COURSE CONTENTS

BUSINESS MANAGEMENT

- 1. ECONOMICS** 3 Hours
 - 1.1 Definition: Adam Smith, Alfred Marshal, Professor Robbins.
 - 1.2 Nature and scope.
 - 1.3 Importance for foreman and technicians.
 - 1.4 Basic concepts in economics (Utility, Marginal, Income, Wealth, Saving, Investment).
 - 2. DEMAND AND SUPPLY** 3 Hours
 - 2.1 Definition.
 - 2.2 Law of Demand.
 - 2.3 Definition of Supply.
 - 2.4 Law of Supply.
 - 3. FACTORS OF PRODUCTION** 3 Hours
 - 3.1 Land.
 - 3.2 Labour.
 - 3.3 Capital.
 - 3.4 Organization.
 - 4. BUSINESS ORGANIZATION** 3 Hours
 - 4.1 Sole proprietorship.
 - 4.2 Partnership.
 - 4.3 Joint Stock Company.
 - 5. SCALE OF PRODUCTION** 3 Hours
 - 5.1 Meaning and its determination.
 - 5.2 Large scale production.
 - 5.3 Small scale production.
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6.	LAWS OF RETURN	3 Hours
6.1	Law of increasing return.	
6.2	Law of constant return.	
6.3	Law of diminishing return.	
7.	ECONOMICS SYSTEMS	3 Hours
7.1	Free economic system.	
7.2	Centrally controlled economy.	
7.3	Mixed economic system.	
8.	MONEY	2 Hours
8.1	Barter system and its inconveniences.	
8.2	Definition of money and its functions.	
9.	BANK	2 Hours
9.1	Definition.	
9.2	Functions of a commercial bank.	
9.3	Central bank and its functions.	
10.	CHEQUE	2 Hours
10.1	Definition.	
10.2	Characteristics and kinds of cheques.	
10.3	Dishonour of cheque.	
11.	FINANCIAL INSTITUTION	3 Hours
11.1	IMF.	
11.2	IDBP.	
11.3	PIDC.	
12.	MANAGEMENT	3 Hours
12.1	Meaning.	
12.2	Functions of management.	
12.3	Problems of business management.	

ACCOUNTING

1.	BOOK KEEPING	3 Hours
1.1	Definition.	
1.2	Objects.	
1.3	Double entry system.	
1.4	Important accounting terms used usually.	

2.	ACCOUNTING	3 Hours
2.1	Definition.	
2.2	Branches.	
2.3	Functions.	
2.4	Parties interested in accounting information.	
3.	NATURE OF ACCOUNTS AND RULES OF DEBIT AND CREDIT	2 Hours
3.1	Classification of accounts.	
3.2	Rules of debit and credit.	
4.	JOURNAL	2 Hours
4.1	Definition and characteristics.	
4.2	Entry.	
4.3	Rules for journalizing.	
5.	LEDGER	2 Hours
5.1	Definition and features.	
5.2	Methods of posting.	
6.	TRIAL BALANCE	3 Hours
6.1	Definition.	
6.2	Objectives.	
6.3	How to prepare it.	
7.	BANKING TRANSACTIONS	2 Hours
7.1	Introduction.	
7.2	Methods of recording such transactions.	
8.	SUB-DIVISION OF JOURNAL-I	2 Hours
8.1	Cash Book and its kinds. (Single, double and three column cash book).	
8.2	The petty cash book and its preparation.	
9.	SUB-DIVISION OF JOURNAL-II	3 Hours
9.1	Purchase and purchase return book.	
9.2	Sales and sales return book.	
9.3	Bills receivable book.	
9.4	Bills payable book.	
10.	DEPRECIATION	2 Hours
10.1	Definition and necessity for charging depreciation.	
10.2	Fixed installment method.	
10.3	Diminishing balance method.	
11.	CAPITAL AND REVENUE	3
	Hours	
11.1	Capital and revenue expenditure.	
11.2	Deferred revenue expenditure.	

- 11.3 Capital and revenue payment.
- 11.4 Capital and revenue profits.
- 11.5 Capital and revenue loss.

- 12. RECTIFICATION OF ERRORS** 2 Hours
 - 12.1 Book keeping and trial balance errors.
 - 12.2 Correcting the errors.

- 13. FINAL ACCOUNTS** 2 Hours
 - 13.1 The concept of final account.
 - 13.2 Preparation of trading profit and loss account.
 - 13.3 Preparation of balance sheet.

BOOKS RECOMMENDED

1. Business Organization, Nisar-ud-Din, Aziz Publishers, Lahore.
 2. An Introduction to Modern Economics, S. M. Akhtar, United Publishers Ltd., Lahore.
 3. Nizamat-e-Sanaat Aur Insani Rawabat by Ghulam Hussain (Ilmi Kitab Khana, Urdu Bazar, Lahore).
 4. The Process of Management by Andrew R. Megill William M. Newman.
 5. Factory and Production Management by K.G. Lockyer.
 6. Financial Accounting, Meigs and Meigs, McGraw Hill Book Co.
 7. Principle of Accounting, M. A. Ghani, H. Y. Printer, Lahore.
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MGM-242: BUSINESS MANAGEMENT AND ACCOUNTING

INSTRUCTIONAL OBJECTIVES

(BUSINESS MANAGEMENT)

1. UNDERSTAND THE IMPORTANCE OF ECONOMICS

- 1.1 State definition of economics given by Adam Smith, Alfred Marshall and Professor Robins.
- 1.2 Explain nature and scope of economics.
- 1.3 Describe importance of study economics for technicians.
- 1.4 Define basic terms, utility, income, wealth, saving, investment and value.
- 1.5 Explain the basic terms with examples.

2. UNDERSTAND LAW OF DEMAND AND LAW OF SUPPLY.

- 2.1 Define demand
- 2.2 Explain law of demand with the help of schedule and diagram.
- 2.3 State assumptions and limitation of law of demand.
- 2.4 Define supply
- 2.5 Explain law of supply with the help of schedule and diagram
- 2.6 State assumptions and limitation of law of supply.

3. UNDERSTAND FOUR FACTORS OF PRODUCTION.

- 3.1 Define the four factors of production
- 3.2 Explain labour and its features.
- 3.3 Describe capital and its peculiarities.

4. UNDERSTAND FORMS OF ORGANIZATION

- 4.1 Describe sole proprietorship, its merits and demerits.
- 4.2 Explain partnership, its advantages and disadvantages.
- 4.3 Describe joint stock company, its merits and demerits.
- 4.4 Distinguish between public limited company and private limited company.

5. UNDERSTAND SCALE OF PRODUCTION

- 5.1 Explain scale of production and its determination.
- 5.2 Describe large scale production and its merits.
- 5.3 Explain small scale of production, its advantages and disadvantages.

6. UNDERSTAND LAW OF RETURN

- 6.1 Explain law of increasing return
- 6.2 Explain law of constant return
- 6.3 Explain law of diminishing return]

7. UNDERSTAND DIFFERENT ECONOMIC SYSTEMS

- 7.1 Describe free economic system and its characteristics.
 - 7.2 Explain centrally planned economic system, its merits and demerits.
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- 7.3 State mixed economic system and its features.
- 8. UNDERSTAND MONEY**
- 8.1 Explain barter system and its inconveniences
- 8.2 Define money.
- 8.3 Explain the factors of money.
- 9. UNDERSTAND BANK AND ITS FUNCTIONS**
- 9.1 Define bank.
- 9.2 Describe commercial bank and its functions.
- 9.3 State central bank and its functions.
- 10. UNDERSTAND CHEQUE AND DISHONOR OF CHEQUE**
- 10.1 Define cheque.
- 10.2 Enlist the characteristics of cheque.
- 10.3 Identify the kinds of cheque.
- 10.4 Describe the causes of dishonor of a cheque.
- 11. UNDERSTAND FINANCIAL INSTITUTIONS.**
- 11.1 Explain IMF and its objectives.
- 11.2 Explain organisational setup and objectives of IDBP.
- 11.3 Explain organisational setup and objectives PIDC.
- 12. UNDERSTAND MANAGEMENT**
- 12.1 Define management
- 12.2 Describe functions of management
- 12.3 Explain the problems of management

(ACCOUNTING)

- 1. UNDERSTAND THE BASIC CONCEPTS OF BOOK KEEPING**
- 1.1 State Book Keeping.
- 1.2 Identify the uses of Book Keeping.
- 1.3 Explain double entry system of Book Keeping.
- 1.4 Describe basic Accounting terms.
- 2. UNDERSTAND ACCOUNTING AND ITS FUNCTIONS**
- 2.1 Define accounting.
- 2.2 Explain functions of accounting.
- 2.3 Describe parties interested in accounting information.
- 3. APPLY RULES OF DEBIT AND CREDIT**
- 3.1 Describe different classes of accounts.
- 3.2 Explain rule of debit and credit.
- 3.3 Apply rule of debit and credit.
- 4. UNDERSTAND JOURNAL**
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- 4.1 Define journal and its features.
 - 4.2 Explain entry.
 - 4.3 Show entry in journal.
 - 4.4 Describe rules of journalizing.
 - 4.5 Apply rules of journalizing.
 - 5. APPLY METHOD OF POSTING**
 - 5.1 Define ledger.
 - 5.2 Describe characteristics of ledger.
 - 5.3 Explain method of posting.
 - 5.4 Apply method of posting.
 - 6. PREPARE TRIAL BALANCE**
 - 6.1 State trial balance.
 - 6.2 List objectives of trial balance.
 - 6.3 Prepare trial balance.
 - 7. RECORDING OF BANKING TRANSACTIONS**
 - 7.1 Describe banking transactions.
 - 7.2 Pass entries of bank transactions.
 - 8. PREPARE CASH BOOK**
 - 8.1 Define cash book.
 - 8.2 Prepare single, double and three column cash book.
 - 8.3 Define petty cash book.
 - 8.4 Prepare petty cash book.
 - 9. PREPARE OTHER SUBSIDIARY BOOK**
 - 9.1 Prepare purchases and purchases return book.
 - 9.2 Prepare sales and sales return book.
 - 9.3 Prepare bills receivable book.
 - 9.4 Prepare bills payable book.
 - 10. APPLY DEPRECIATION METHODS**
 - 10.1 Define depreciation.
 - 10.2 State necessity for charging depreciation.
 - 10.3 Apply fixed installment method.
 - 10.4 Apply diminishing balance method.
 - 11. DISTINGUISH CAPITAL AND REVENUE EXPENDITURE: CAPITAL AND REVENUE RECEIPTS**
 - 11.1 Differentiate between capital and revenue expenditure.
 - 11.2 Differentiate between capital and revenue receipts.
 - 12. RECTIFY THE ACCOUNTING ERRORS**
 - 12.1 Identify the errors in books of accounts.
 - 12.2 Correct the errors found in books of accounts.
 - 13. PREPARE ANNUAL ACCOUNTS**
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- 13.1 Describe final accounts.
- 13.2 Prepare trading accounts.
- 13.3 Prepare profit and loss account.
- 13.4 Prepare balance sheet.

Phy-212: APPLIED PHYSICS / APPLIED MECHANICS

T	P	C
1	3	2

Total contact hours:

Theory	32
Practical	96

LEARNING OUTCOMES

1. Apply the concepts of Applied Physics to understand Mechanics.
2. Apply laws and principles of Mechanics in solving technological problems.
3. Use the knowledge of App. Mechanics in learning advance technical courses.
4. Demonstrate efficient skill of Practical work in Mechanics Lab.

COURSE CONTENTS

1. **MEASUREMENTS** 2 Hours
 - 1.1 Review: Dimensional formula of Equations of Motion
 - 1.2 Review: Systems of measurement, S.I. Units, conversion
 - 1.3 Significant Figures
 - 1.4 Degree of accuracy
 2. **EQUILIBRIUM OF CON-CURRENT FORCES** 3 Hours
 - 2.1 Concurrent forces
 - 2.2 Addition and Resolution of Vectors
 - 2.3 Toggle Joint, Hanging Chains
 - 2.4 Roof Trusses, Cranes.
 - 2.5 Framed structures
 3. **MOMENTS AND COUPLES** 2 Hours
 - 3.1 Principle of Moments – Review
 - 3.2 Levers
 - 3.3 Safety valve
 - 3.4 Steel yard
 - 3.5 Parallel forces, couple
 - 3.6 Torque
 4. **EQUILIBRIUM OF NON CONCURRENT FORCES** 3 Hours
 - 4.1 Non-concurrent forces
 - 4.2 Free body diagram
 - 4.3 Varignon's theorem
 - 4.4 Conditions of total equilibrium
 - 4.5 Ladders
 5. **MOMENT OF INERTIA** 3 Hours
 - 1.1 Review: Rotational Inertia
 - 1.2 Moment of Inertia, Theorems
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1.3	Moment of Inertia of symmetrical bodies	
1.4	M.I. of Fly wheel with applications	
1.5	Energy stored by Fly wheel	
6.	FRICITION	2 Hours
6.1	Review: Laws of friction	
6.2	Motion of body along an inclined plane (up & down)	
6.3	Rolling friction & Ball Bearings	
6.4	Fluid Friction, Stoke's Law	
7.	WORK, ENERGY AND POWER	3 Hours
7.1	Work-Energy relationship	
7.2	Work done by variable force	
7.3	Power	
7.4	I.H.P., B.H.P. and Efficiency	
7.5	Dynamometer	
8.	TRANSMISSION OF POWER	3 Hours
8.1	Belts, Ropes.	
8.2	Chains	
8.3	Gears	
8.4	Clutches, functions and types with application	
9.	MACHINES	3 Hours
9.1	Efficiency of machines	
9.2	Inclined plane – Review	
9.3	Reversibility of machines	
9.4	Single purchase crab	
9.5	Double purchase crab	
9.6	Worm and worm wheel	
9.7	Differential Screw Jack	
9.8	Differential Pulley, Wheel and Axle	
10.	VIBRATORY MOTION	2 Hours
10.1	S.H.M. – Review	
10.2	Pendulums	
10.3	Speed Governors	
10.4	Helical spring	
10.5	Cams	
10.6	Quick return motion	
11.	ELASTICITY	3 Hours
11.1	Three Modulii of Elasticity	
11.2	Loaded Beams, Types of Beam & Loads	
11.3	Bending Stress	
11.4	S.F. & B.M. diagram	
11.5	Torsion and Torsional Stresses	

12.	SIMPLE MECHANISM	1 Hour
12.1	Introduction	
12.2	Kinematic link or Element	
12.3	Kinematic pair and types	
12.4	Kinematic chains and types	
13.	VELOCITY IN MECHANISM	2 Hours
13.1	Introduction	
13.2	Instantaneous centre	
13.3	Instantaneous velocity	
13.4	Velocity of a link by instantaneous centre method	
13.5	Relative velocity of two bodies in the straight line	
13.6	Velocity of a link by relative velocity method	

INSTRUCTIONAL OBJECTIVES

- 1. USE THE CONCEPTS OF MEASUREMENT IN PRACTICAL SITUATIONS/PROBLEMS**
 - 1.1 Explain Dimensional formula
 - 1.2 Explain systems of measurement
 - 1.3 Use concept of significant figures and degree of accuracy to solve problems
 - 2. USE THE CONCEPT OF ADDITION AND RESOLUTION OF VECTORS TO PROBLEMS ON EQUILIBRIUM INVOLVING CONCURRENT FORCES**
 - 2.1 Describe concurrent forces
 - 2.2 Explain resolution of vectors
 - 2.3 Use the analytical method of addition of vectors for solving problems.
 - 2.4 Use the graphical method of addition of solving problems.
 - 2.5 Solve problems on forces with emphasis on roof trusses, cranes simple frames and framed structures.
 - 3. USE THE PRINCIPLE OF MOMENTS AND CONCEPT OF COUPLE TO SOLVE PROBLEMS**
 - 3.1 Describe the principle of moments.
 - 3.2 Use the principle of moments to solve problems on compound levers, safety valve, steel-yard.
 - 3.3 Describe couple and torque.
 - 3.4 Use the concept to solve problems on torque.
 - 4. USE THE LAWS OF TOTAL EQUILIBRIUM OF FORCES TO SOLVE PROBLEMS INVOLVING FORCES IN EQUILIBRIUM**
 - 4.1 Distinguish between concurrent and non-concurrent forces.
 - 4.2 Prepare a free body diagram of an object or a structure
 - 4.3 Explain Varignon's theorem.
 - 4.4 Explain the second condition of equilibrium
 - 4.5 Use laws of total equilibrium to solve problems on forces involving framed structure and ladders.
 - 5. USE CONCEPTS OF MOMENT OF INERTIA TO PRACTICAL SITUATIONS AND PROBLEMS**
 - 5.1 Explain moment of inertia
 - 5.2 Explain the theorems of parallel and perpendicular axis
 - 5.3 Describe the M.I. of regular bodies
 - 5.4 Explain M.I. of fly wheel
 - 5.5 Explain energy stored by fly wheel
 - 5.6 Use these concepts to solve simple problems.
 - 6. UNDERSTAND THE CONCEPTS AND LAWS OF SOLID AND FLUID FRICTION**
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- 6.1 Define coefficient of friction between a body placed on an inclined plane and the surface.
 - 6.2 Explain motion of a body placed on an inclined plane
 - 6.3 Calculate the force needed to move a body up and down an inclined plane.
 - 6.4 Explain rolling friction and use of ball bearings
 - 6.5 Describe fluid friction and Stoke's law.
 - 7. UNDERSTAND WORK, ENERGY AND POWER**
 - 7.1 Derive work-energy relationship
 - 7.2 Use formulae for work done by a variable force to solve problems.
 - 7.3 Explain Power, I.H.P., B.H.P. and efficiency.
 - 7.4 Describe dynamometers.
 - 7.5 Use the concepts to solve problems on power and work energy.
 - 8. UNDERSTAND TRANSMISSION OF POWER THROUGH ROPES AND BELTS**
 - 8.1 Describe the need for transmission of power.
 - 8.2 Describe methods of transmission of power.
 - 8.3 Describe transmission of power through ropes and belts.
 - 8.4 Write formula for power transmitted through ropes and belts.
 - 8.5 Describe transmission of power through friction gears and write formula.
 - 8.6 Describe transmission of power through chains and toothed wheels/gears.
 - 8.7 Use the formulae to solve/problems on transmission of power.
 - 8.8 Describe types and function of clutches with applications.
 - 9. USE THE CONCEPTS OF MACHINES TO PRACTICAL SITUATIONS**
 - 9.1 Explain theoretical, actual mechanical advantage and efficiency of simple machines.
 - 9.2 Use the concept to calculate efficiency of an inclined plane
 - 9.3 Describe reversibility of machines.
 - 9.4 Calculate the efficiency of:
 - (i) Single purchase crab.
 - (ii) Double purchase crab.
 - (iii) Worm and worm wheel.
 - (iv) Differential screw jack, Diff. pulley, wheel and axle.
 - 9.5 Use the formulae to solve the problems involving efficiency, M.A. of the above machines.
 - 10. USE THE CONCEPTS OF VIBRATORY MOTION TO PRACTICAL SITUATIONS**
 - 10.1 Define vibratory motion giving examples.
 - 10.2 Describe circular motion and its projection on diameter of the circular path.
 - 10.3 Relate rotatory motion to simple vibratory motion.
 - 10.4 State examples of conversion of rotatory motion to vibratory motion and vice versa.
 - 10.5 Describe speed governors, cams, quick return motion.
 - 10.6 Derive formulae for position, velocity and acceleration of a body executing S.H.M.
 - 10.7 Use the concept of S.H.M. to helical springs.
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10.8 Use the concept of S.H.M. to solve problems on pendulum.

11. UNDERSTAND BENDING MOMENTS AND SHEARING FORCES

11.1 Define three types of stresses and moduli of elasticity.

11.2 Describe types of beams and loads.

11.3 Explain shearing force and bending moment.

11.4 Use these concepts to calculate S.F. and B.M. in a given Practical situation for point loads, uniformly distributed load.

11.5 Prepare S.F. and B.M. diagram for loaded cantilever and simply supported beams.

11.6 Describe torsion and torsional stresses giving formula.

12. UNDERSTAND SIMPLE MECHANISMS

12.1 Define simple mechanisms.

12.2 Define kinematics.

12.3 Explain kinematic link or element.

12.4 Explain kinematic chains.

12.5 Distinguish between types of kinematic chains.

13. UNDERSTAND THE METHOD OF FINDING VELOCITY IN MECHANISMS.

13.1 Explains relative velocity.

13.2 Explain instantaneous center.

13.3 Explain instantaneous velocity.

13.4 Explain the method of finding velocity of a link by:

(i) Relative velocity method.

(ii) Instantaneous center method.

LIST OF EXPERIMENTS

On completion of this course, the trainees will be able to;

1. Find the weight of the given body using Law of Polygon of forces.
 2. Find unknown forces in a given set of concurrent forces in equilibrium using Gravesands apparatus
 3. Set a jib crane and analyse forces in its members
 4. Set a Derrick Crane and analyse forces in its members
 5. Study forces shared by each member of a Toggle Joint.
 6. Set a Roof Truss and find forces in its members.
 7. Verify Principle of Moments in a compound lever.
 8. Calibrate a steelyard.
 9. Find the Reactions at the ends of a loaded beam.
 10. Use Reaction of Beams apparatus to study resultant of parallel forces.
 11. Find the Moment of Inertia of a Flywheel.
 12. Find the angle of reaction of a wooden block placed on an inclined plane.
 13. Find the B.H.P. of a motor.
 14. Study the transmission of Power through friction gears.
 15. Study the transmission of Power through belts.
 16. Study the transmission of Power through toothed wheels
 17. Study the function of clutches.
 18. Find M.A. and Efficiency of worm and worm wheel.
 19. Find M.A. and efficiency of differential wheel and axle.
 20. Find the efficiency of a screw.
 21. Find the efficiency of a differential pulley
 22. Study conversion of rotatory motion to S.H.M. using S.H.M. Model/Apparatus.
 23. Study conversion of rotatory motion to vibratory motion of the piston in a cylinder.
 24. Study the reciprocating motion.
 25. Study the working of cams.
 26. Study the quick return motion.
 27. Compare the Elastic constants of the given wires.
 28. Verify Hooke's Law using Helical Spring.
 29. Find the coefficient of Rigidity of a wire using Maxwell's needle.
 30. Find the coefficient of Rigidity of a round bar using torsion apparatus.
 31. Find the coefficient of Rigidity of a rectangular bar using Deflection of Beam apparatus.
 32. Determine S.F. and B.M. in a loaded cantilever (Point Loads).
 33. Determine S.F. and B.M. in a simply supported Beam (Point Loads).
 34. Determine S.F. and B.M. in a simply supported Beam (Point loads and uniformly distributed load).
 35. Determine S.F. and B.M. in a simply supported Beam (Point loads and uniformly distributed).
 36. Study working and function of link mechanism of different types.
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BOOKS RECOMMENDED:

1. Applied Mechanics by R.S. Khurmi.
 2. Applied Mechanics by A.P.S. Sahihney & Prakash D. Manikpyny.
 3. Applied Mechanics by Inchley and Morley.
 4. Theories of Machines by R.S. Khurmi and J.K. Gupta.
 5. Applied Mechanics by Junarker.
 6. Engineering Science Vol-I by Brown and Bryant
 7. Practical Physics by Mehboob Ilahi Malik & Ikram-ul-Haq.
 8. Experimental Physics Note Book by M. Aslam Khan & M. Akram Sandhu
 9. Experimental Mechanics (Urdu Process) by M. Akram Sandhu.
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HVAC-205: PRINCIPLES OF AIR-CONDITIONING

T	P	C
3	6	5

Total contact hours

Theory	96 hours
Practical	192 hours

LEARNING OUTCOMES:

1. At the end of the course the students will be able to understand principles of air-conditioning, properties of air, psychrometric charts, psychrometric calculation, comfort and effective temperature, air-conditioning methods, state and quantity of supply air, humidification and dehumidification of air.
2. Understand psychrometric and perform heat load calculation, and calculations for the conditioned air supply.

PART-A**1. INTRODUCTION TO AIR CONDITIONING. 4 Hours**

- 1.1 Introduction of comfort air conditioning.
- 1.2 Introduction to equipment used in air conditioning systems
- 1.3 Classification of Air conditioning systems.
- 1.4 Scope of air conditioning

2. REVIEW OF HEAT ENERGY 4 Hours

- 2.1 Sensible heat.
- 2.2 Latent heat.
- 2.3 Total heat
- 2.4 Specific heat & its Types.
- 2.5 Problem solving

3. PSYCHROMETRIC PROPERTIES OF AIR 16 Hours

- 3.1 The composition of moist air
 - 3.2 Partial Pressure of Water Vapor
 - 3.3 The laws of gases
 - 3.4 Use of steam table
 - 3.5 Dry bulb temperature (DBT).
 - 3.6 Wet bulb temperature (WBT)
 - 3.7 Sling psychrometer
 - 3.8 Dew point temperature (DPT)
 - 3.9 Specific humidity (Sp.H)
 - 3.10 Relative humidity (RH).
 - 3.11 Specific volume (Sp.Vol)
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3.12	Enthalpy (h)	
3.13	Problem Solving	
4.	AIR AND HUMAN COMFORT.	6 Hours
4.1	Effect of air temperature and humidity on human comfort.	
4.2	Impact of filtration on human comfort.	
4.3	Ventilation requirement and air movement for comfort.	
4.4	COMFORT zone	
4.5	Effective temperature.	
4.6	Factors of A.C. design.	
5.	ENERGY CONSERVATION	12 Hours
5.1	The Concept of Energy Conservation and sustainability	
5.2	Kinds of Energy To be conserved	
5.3	Sources of energy & their utilization	
5.4	Standards and codes.	
5.5	Analysis (measuring) energy conservation.	
5.6	Energy conservation by degree day method.	
5.7	Principles of Energy Recovery	
5.8	Integration of Dedicated Outdoor Air System (DOAS) with ERV/HRV for energy recovery.	
5.9	Use of Software and cloud-based energy analytics in HVAC&R system.	
5.10	Demand-controlled ventilation for energy optimization.	
5.11	Problem solving.	
	<u>PART-B</u>	
6.	PSYCHROMETRIC CHARTS	10 Hours
6.1	Psychrometric chart.	
6.2	Dry bulb temperature lines.	
6.3	Wet bulb temperature lines.	
6.4	Dew point temperature line.	
6.5	Specific humidity lines.	
6.6	Relative humidity lines.	
6.7	Specific volume lines.	
6.8	Enthalpy lines	
6.9	Saturation lines.	
6.10	Problem solving.	
6.11	Use of psychrometric software for plotting	
7.	PSYCHROMETRIC PROCESSES.	16 Hours
7.1	Cooling.	
7.2	Heating.	
7.3	Humidification	
7.4	Dehumidification	
7.5	Cooling and humidification	
7.6	Cooling and dehumidification.	
7.7	Heating and humidification.	
7.8	Heating and dehumidification.	
7.9	Air mixing process.	
7.10	Sensible heat ratio (SHR)	
7.12	By pass factor (BF)	

- 7.12 Apparatus dew point (ADP)
- 7.13 Standard design conditions. (SRDC)
- 7.14 Use of psychrometric software for process analysis

8. CALCULATION ON PSYCHROMETRIC PROCESSES. 12 Hours

Solution of problems on topics from 7.1 to 7.12

9. CALCULATION FOR THE CONDITIONED AIR SUPPLY. 16 Hours

- 9.1 Heating or cooling with air
- 9.2 Moisture calculations.
- 9.3 Sensible heat, Latent heat and Total heat calculations.
- 9.4 Dry bulb temperature and humidity.
- 9.5 By passed return air.
- 9.6 By passed outdoor air.
- 9.7 By passed mixed air.
- 9.8 The air conditioning cycle.
- 9.9 Capacity of refrigerating plant.
- 9.10 Problem solving

RECOMMENDED BOOKS AND SOFTWARES

1. ASHRAE Fundamentals 2005
2. Trane Air Conditioning manual.
3. Carrier system design Manual.
4. Air conditioning and Refrigeration by Norman Harries.
5. Modern Refrigeration and Air conditioning by Althouse.
6. Principles of Air conditioning by Lang.
7. Manual prepared by National Institute of Science & Technology (NISTE), Ministry of Education, Government of Pakistan, Islamabad.
8. **Softwares:**
 - Carrier Psychrometric Analysis
 - McQuay Psychrometric Analyzer
 - HVACSIM+ (by NIST)
 - TRNSYS
 - HVAC Simulator (HVACSim / HVAC Simulator Pro)
 - ESCO Institute HVACR Virtual Lab Simulations

HVAC-205: PRINCIPLES OF AIR-CONDITIONING

INSTRUCTIONAL OBJECTIVES:

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

1. UNDERSTAND THE IMPORTANCE OF AIR-CONDITIONING.

- 1.1 Define comfort air conditioning
- 1.2 Name the equipment used in an air conditioning system.
- 1.3 Enlist the types of air-conditioning.
- 1.4 Explain the scope of air conditioning.

2. UNDERSTAND THE HEAT ENERGY AND ITS TYPES.

- 2.2 Define sensible heat
- 2.3 Define latent heat
- 2.4 Define total heat.
- 2.5 Explain the specific heat and its types.
- 2.5 Solve problems on sensible heat and latent heat.

3. UNDERSTAND THE PRINCIPLES OF PSYCHROMETRY

- 3.1 Explain the dry air and water vapour in the air (moist air).
- 3.2 Explain partial pressure of water vapor.
- 3.3 State Boyle's law, Charles's law, Gay Lussac's Law, General Gas Law, Dalton's Law of Partial Pressure.
- 3.4 Explain the use of steam table.
- 3.5 Define, DB, WB, DP temperature with units.
- 3.6 Explain the sling psychrometer and its use.
- 3.7 Define specific humidity, Relative Humidity, Specific volume and enthalpy with units.
- 3.8 Solve relevant problems.

4. KNOW THE PRINCIPLES INVOLVED IN THE AIR AND HUMAN COMFORT.

- 4.1 Discuss the effect of air temperature and humidity on human comfort.
- 4.2 State the ventilation requirement and air movement for human comfort.
- 4.3 Explain impact of air filtration including Ultraviolet Germicidal Irradiation (UVGI) on human comfort.
- 4.4 Describe effective temperature and its importance.
- 4.5 Describe comfort zone.
- 4.6 Describe factors of A/C design (Effective temperature, Heat production and regulation in human body, Heat and moisture losses from the human body, Moisture content of air, Quality and quantity of air, Air motion, Hot & cold surfaces and Air stratification)

5. UNDERSTAND ENERGY CONSERVATION

- 5.1 Define energy conservation and sustainability.
 - 5.2 Name the kinds of energy which can be conserved.
 - 5.3 Describe the sources of energy & their utilization.
 - 5.4 Explain the analysis (measuring) of energy conservation in different processes.
 - 5.5 Describe the energy conservation by degree day method.
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- 5.6 Describe principles of energy recovery.
 - 5.7 Describe integration of Dedicated Outdoor Air System (DOAS) with ERV/HRV for energy recovery.
 - 5.8 Explain the use of software and cloud-based energy analytics in HVAC&R systems.
 - 5.9 Explain Demand-controlled ventilation for energy optimization
 - 5.10 Solve problems.
 - 6. UNDERSTAND THE ROLE OF PSYCHROMETRIC CHART.**
 - 6.1 Trace the lines of DB, WB, DPT, Specific humidity, RH, Sp. volume, saturation lines on psychrometric chart.
 - 6.2 Explain the form of lines and their units.
 - 6.3 Solve problems.
 - 6.4 Explain plotting of different psychrometric terms on psychrometric software.
 - 7 UNDERSTAND THE PROCESS OR PROCESSES INVOLVED IN PSYCHROMETRIC CHART**
 - 7.1 Trace cooling and heating process on psychrometric chart.
 - 7.2 Trace humidification and dehumidification processes.
 - 7.3 Explain the cooling and humidification, cooling and dehumidification processes.
 - 7.4 Explain heating and humidification process.
 - 7.5 Explain the air-mixing process and trace on psychrometric chart.
 - 7.6 Describe sensible heat ratio and by pass factor.
 - 7.7 Explain apparatus dew point and standard design conditions.
 - 7.8 Explain psychrometric process analysis with the help of software
 - 8. UNDERSTAND THE PSYCHROMETRIC PROCESSES CALCULATIONS**
 - 8.1 Solve problems on topics 7.1 to 7.12 with the help of psychrometric chart
 - 9. UNDERSTAND THE CONDITIONED AIR SUPPLY CALCULATIONS.**
 - 9.1 Solve problems relating to heating of air, cooling of air and moisture contents.
 - 9.2 Calculate latent heat, quantity of air and condition of the air supply.
 - 9.3 Calculate the quantity of bypassed return air, bypassed out door air and sensible heat ratio.
 - 9.4 Illustrate the air conditioning cycle with the help of psychrometric chart.
 - 9.5 Explain the capacity of a refrigerating plant.
-

HVAC-205: PRINCIPLE OF AIR-CONDITIONING

LIST OF PRACTICALS

(Total 192 Hours)

On completion of this course, the trainees will be able to;

A. PSYCHROMETICS

18 Hours

1. Measure wet-bulb and dry-bulb temperatures using a sling psychrometer.
2. Calculate psychrometric properties using a psychrometric chart.
3. Analyze the condition of air being conditioned by an air conditioning unit using a psychrometric chart, and verify the results using psychrometric analysis software.
4. Analyze the condition of air passing over the condenser coil of an air conditioning system using a psychrometric chart, and verify the results using psychrometric analysis software.
5. Compare the condition of air before and after passing over the evaporator coil of an air conditioning unit using a psychrometric chart, and verify the results using psychrometric analysis software.
6. Perform a psychrometric analysis of a VRF/Heat Pump system using psychrometric analysis software.

B. SERVICING AND TESTING PROCEDURES OF AIR CONDITIONING SYSTEMS

78 Hours

7. Install a window air conditioning unit.
8. Service a window air conditioning unit.
9. Test and adjust the performance of a window air conditioning unit.
10. Inspect and connect the electrical circuit of a window air conditioning unit.
11. Evacuate a split air conditioning unit using a vacuum pump.
12. Add compressor oil to a split air conditioning unit in accordance with manufacturer specifications.
13. Charge refrigerant into a split air conditioning unit using the appropriate charging method.
14. Test the fan motor of an inverter split air conditioning unit.
15. Service an inverter split air conditioning unit.
16. Perform a leak test on a split air conditioning unit.
17. Install a split air conditioning unit in accordance with standard installation practices.
18. Examine the components of a remote condensing unit and demonstrate standard installation practices.
19. Evaluate the efficiency of an air-cooled condenser using operating parameters.
20. Use a digital psychrometer to evaluate the response of an air conditioning unit to changes in outdoor ambient temperature.
21. Use a digital psychrometer to evaluate the performance of an air-cooled condenser.
22. Determine the operating high-side pressure of an air conditioning unit.

C. SIMULATION

96 Hours

23. Analyze and troubleshoot air conditioning systems using computer simulation software.

Fault conditions

**The air-conditioning system operates under the following selected fault conditions.
Demonstrate to show and how the system operates every student perform the repair of**

fault data (fault activity, log-on time, repair actions, etc.) using the demo fault computer simulation program.

- 23.1 Refrigerant undercharge due to leak
 - 23.2 Refrigerant overcharge
 - 23.3 Compressor stuck (locked rotor)
 - 23.4 Evaporator coil dirty
 - 23.5 Condenser coil dirty
 - 23.6 Air filter dirty
 - 23.7 Compressor valve defective
 - 23.8 Capillary tube partially restricted
 - 23.9 TX valve stuck open
 - 23.10 TX valve power element dead
 - 23.11 Thermostat stuck open
 - 23.12 Start relay coil open
 - 23.13 Compressor run winding shorted to ground
 - 23.14 Contactor contact high-resistance
 - 23.15 Indoor fan motor relay coil open
 - 23.16 Outdoor fan motor winding open
 - 23.17 Control transformer primary winding open
 - 23.18 Indoor fan motor run capacitor open
 - 23.19 Contactor coil open
 - 23.20 Defective circuit breaker
-

HVAC-213: APPLIED THERMODYNAMICS IN HVAC&R SYSTEMS

T	P	C
2	3	3

Total contact hours

Theory	64 hours
Practical	96 hours

Learning Outcomes:

1. To enable the student to acquire basic knowledge of thermodynamics applied to air conditioning, heating and expansion of gases, Laws of perfect gases, air cycles and reversibility.
2. To familiarize with the basic knowledge of low pressure boiler, application of boiler in air conditioning, its controls, chemical treatment of boilers / water and feed water tanks.

1. **THERMODYNAMICS PROCESSES** 10 Hours
 - 1.1 Introduction of temperature, pressure, gases and vapour.
 - 1.2 Laws of perfect gases, gas equation and specific heat of gases.
 - 1.3 Energy equation of a gas.
 - 1.4 Change in internal energy.
 - 1.5 Graphical representation of work done by a gas.
 - 1.6 Reversible & Irreversible Processes
 - 1.7 Constant volume process, constant pressure process, isothermal process, hyperbolic process, isentropic process, polytropic process ($PV^n = C$), free expansion, and throttling process.
 - 1.8 Problem solving.
 2. **AIR CYCLES** 8 Hours
 - 2.1 Cycle of operation.
 - 2.2 Reverse Otto cycle, its efficiency and its application.
 - 2.3 Reverse Carnot's cycle, its efficiency and its application.
 - 2.4 Reverse Joule's cycle, its efficiency and its application.
 - 2.5 Reverse Rankin Cycle, its efficiency and its application.
 - 2.6 Mean Effective Pressure. M. E. P.
 - 2.7 Problem solving.
 3. **RECIPROCATING AIR COMPRESSOR.** 8 Hours
 - 3.1 Air compressors.
 - 3.2 Classification of compressors.
 - 3.3 Effect of the type of compression.
 - 3.4 Inter-Cooling
 - 3.5 Single stage compression and multistage compression.
 - 3.6 Work done per cycle and power required using PV diagram method.
 - 3.7 Efficiency of a compressor volumetric efficiency.
 - 3.8 Conditions for maximum efficiency.
 - 3.9 Problem solving.
-

- 4. PROPERTIES OF FLUID AND FLOW OF FLUID.** 8 Hours
- 4.1 Properties of fluid.
 - 4.2 The four stages of substance.
 - 4.3 Properties of vapour.
 - 4.4 Equation of continuity.
 - 4.5 Pressure head, velocity head, datum head, and total head.
 - 4.6 Bernoulli's theorem.
 - 4.7 Flow through orifices, coefficients due to contraction, velocity, and discharge.
 - 4.8 Problem solving.
- 5. BOILERS** 20 Hours
- 5.1. Definition of boiler.
 - 5.2. Classification and types of boilers.
 - 5.3. Low pressure boilers.
 - 5.4. Difference between high pressure and low-pressure boilers.
 - 5.5. Fitting and accessories of boilers.
 - 5.6. Application of low-pressure boilers in air conditioning.
 - 5.7. Types of boilers used in air conditioning.
 - 5.8. Importance of boilers in winter and summer air conditioning.
 - 5.9. Types and uses of steam traps in air conditioning.
 - 5.10. Controls used in low pressure boilers, (Multiple timer),
 - 5.11. Safety valves, flame detection devices, (Photo cell).
 - 5.12. Adjustment of flame with the help of linkage of reversing motor.
 - 5.13. Burners and its types.
- 6. WATER TREATMENT** 6 Hours
- 6.1 Importance of water treatment in air-conditioning.
 - 6.2 Chemical treatment of boilers.
 - 6.3 Blow down and shut down procedure of boiler.
 - 6.4 Use of chemical by-pass feeder for steam/hot water lines. Condensate tank and feed water tank for boilers.
 - 6.5 Use of water softener in air-conditioning (single/double).
- 7. ELECTRICAL CIRCUITS** 4 Hours
- 7.1 Elementary electric circuit diagram of low-pressure boiler panel.
 - 7.2 Actual electric circuit diagram of low-pressure boiler panel.
 - 7.3 General features and remedies of low-pressure boiler.

REFERENCE BOOKS

- 1. Thermodynamics by R.S. Khurmi
 - 2. Heat Engines by D.A. Low.
 - 3. ASHRAE Handbook- Equipment, System and Application volumes.
 - 4. Applied Thermodynamics by T. D. Eastop & McKonkey
 - 5. Manual prepared by National Institute of Science & Technology (NISTE), Ministry of Education, Government of Pakistan, Islamabad
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INSTRUCTIONAL OBJECTIVES:

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

1. UNDERSTAND THE THERMODYNAMICS PROCESSES

- 1.1 Define absolute temperature, units of heat, pressure, gases and vapours.
- 1.2 Explain the laws of perfect gases, derive gas equation and define specific heat of gases.
- 1.3 Explain energy equation of a gas.
- 1.4 State change in internal energy
- 1.5 Represent graphically the work done by a gas.
- 1.6 Explain Reversible & Irreversible Processes
- 1.7 Explain heating and expanding process of gases.
- 1.8 Solve Problems.

2. UNDERSTAND THE PRINCIPLES OF AIR CYCLES

- 2.1 Describe cycle of operation.
- 2.2 Explain Reverse Otto standard cycle, its efficiency and its application.
- 2.3 Explain Reverse Carnot's cycle, its efficiency and its efficiency and its application.
- 2.4 Explain Reverse Joule's cycle, its efficiency and its application.
- 2.5 Explain Reverse Rankin Cycle, its efficiency and its applications
- 2.6 Explain Mean Effective Pressure. (M.E.P.)
- 2.7 Solve problems

3. UNDERSTAND THE RECIPROCATING AIR COMPRESSORS

- 3.1 Explain air compressors.
- 3.2 Classify compressors.
- 3.3 State the effect of the type of compression.
- 3.4 Describe Inter-Cooling
- 3.5 Explain single stage compression and multistage compression
- 3.6 Explain work done per cycle and power required, using PV diagram method.
- 3.7 Define volumetric efficiency of a compressor.
- 3.8 Explain conditions for maximum efficiency.
- 3.9 Solve problems.

4. UNDERSTAND THE PROPERTIES OF FLUID AND FLOW OF FLUID.

- 4.1 State properties of fluid.
 - 4.2 Define the four stages of substance.
 - 4.3 State properties of vapour.
 - 4.4 Explain equation of continuity.
 - 4.5 Define pressure head, velocity head, datum head, and total head.
 - 4.6 Explain Bernoulli's theorem.
 - 4.7 Describe flow through orifices, calculate coefficients due to contraction, velocity, and discharge.
 - 4.8 Solve problems.
-

5. UNDERSTAND THE BOILER AND ITS TYPES.

- 5.1 Define boiler.
- 5.2 Explain classification of boilers.
- 5.3 State low-pressure boilers.
- 5.4 Differentiate between high pressures, low-pressure, hot water boilers.
- 5.5 Identify fittings and accessories of boilers.
- 5.6 Explain the application of low-pressure boilers in air conditioning.
- 5.7 Enlist the types of boilers used in air conditioning.
- 5.8 Explain the Importance of boilers in winter and summer air conditioning.
- 5.9. Explain the types and uses of steam traps in air conditioning.
- 5.10 Explain the controls used in low-pressure boilers, (multiple timer),
- 5.11 Define the safety valves, flame detection devices, (photo cell).
- 5.12 Explain the adjustment of flame with the help of linkage of reversing motor.
- 5.13 Explain Burners and its types.

6. UNDERSTAND THE IMPORTANCE OF WATER TREATMENT.

- 6.1 Explain the importance of water treatment in air-conditioning.
- 6.2 Describe the chemical treatment of boilers.
- 6.3 Explain the blow down and shut down procedure of boiler.
- 6.4 Describe the use of chemical by-pass feeder for steam/hot water lines, condensate tank and feed water tank for boilers.
- 6.5 Explain the use of water softener in air-conditioning

7. UNDERSTAND THE ELECTRICAL CIRCUITS OF BOILER CONTROL PANEL.

- 7.1 Describe elementary electric circuit diagram of low pressure boiler panel.
 - 7.2 Draw actual electric circuit diagram of low pressure boiler panel.
 - 7.3 Explain general features and remedies of low pressure boiler.
-

LIST OF PRACTICAL

Total 96 Hours.

1. Identify various safety devices and protocols related to thermodynamics.
 2. Use various temperature measuring instruments.
 3. Use various pressure measuring instruments.
 4. Demonstrate the P–V diagram and thermodynamic reversibility of the air cycle.
 5. Demonstrate the following thermodynamic cycles and determine their air-standard efficiency and mean effective pressure:
 - 5.1 Reverse Otto Cycle
 - 5.2 Reverse Carnot Cycle
 - 5.3 Reverse Joule Cycle
 - 5.4 Reverse Rankine Cycle
 6. Identify and demonstrate the operation of various types of air compressors.
 7. Observe and verify the properties of fluids and vapors related to the continuity equation and Bernoulli's theorem.
 8. Perform experiments to determine the coefficients of contraction, velocity, and discharge of orifices.
 9. Draw neat, labeled freehand sketches of different boiler fittings.
 10. Draw neat, labeled freehand sketches of different types of boilers showing their mountings.
 11. Sketch various boiler accessories.
 12. Perform experiments on a steam boiler to measure operating parameters and determine boiler efficiency.
 13. Sketch the line diagram of water treatment systems.
 14. Demonstrate the operation of controls used in low-pressure boilers, including multiple timers, safety relief valves, photocells, and flame adjustment controls.
 15. Draw elementary and actual electrical circuit diagrams of low-pressure boilers.
 16. Test the efficiency of an oil pump using an oil pressure gauge.
 17. Test boiler venting using an air draft gauge.
 18. Perform a stack flue gas analysis to measure CO₂, SO₂, and O₂ concentrations.
 19. Install and operate a blower-type gas burner with electric ignition.
 20. Install and operate a gun-type oil burner.
 21. Remove, clean, and replace an oil burner nozzle.
 22. Diagnose and troubleshoot faults in a gas burner system.
 23. Inspect boiler components and observe boiler operation during an industrial visit.
 24. Inspect and observe water treatment systems during an industrial visit.
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HVAC-263: ENGINEERING, ARCHITECTURAL, & COMPUTER AIDED DRAWING

T	P	C
1	6	3

Total contact hours

Theory	32 hours
Practical	192 hours

LEARNING OUTCOMES : The course has been designed to give the technicians an understanding of engineering and architectural drawing for installing & troubleshooting an HVAC&R system alongwith familiarity with AutoCAD Software:

- a. Read and Interpret Engineering drawings
- b. Read & Interpret Architectural drawings.
- b. Execute simple working drawings related to HVAC&R systems.
- c. Understand the installation drawings of air conditioning system and coordination drawings
- d. Know the architectural drawing of buildings & symbols used in Plumbing & HVAC&R Systems.
- e. Understand basics of building information modeling (BIM) for HVAC and integration with MEP services

ENGINEERING DRAWING**6 Hours**

- 1.1 Introduction to Engineering Drawing
- 1.2 Introduction to Architectural Drawing.
- 1.2 Sectional views and its types
- 1.3 Sketching and drawing in isometric and orthographic projections of piping system.
- 1.4 Representation of inclined and curved surfaces.
- 1.5 Development of surfaces like truncated pipes, intersection; of two pipe, square and rectangular ducts.

SYMBOLS FOR PIPING, PIPE FITTINGS, VALVES & DUCTING 14 Hours

- 1.3 Symbols used in plumbing and HVAC&R system drawings
- 1.4 Electrical Symbols used in Engineering Drawing
- 1.5 Representation of Pipes and ducts hanging with roof and walls
- 1.6 Types of wall brackets and roof clamps
- 1.7 Pipe lines drawings, using pipe fitting symbols (single line and double line)
- 1.8 Pipe fittings, study and use of screwed, flanged and welded ends pipeconnections
- 1.9 Pipes and piping system drawings
- 1.10 Ducting system drawings
- 1.11 Pipes and types of pipes like welded, seamless, concrete and ceramics
- 1.12 Valves and their types like globe, gate, check, cock, and relief etc. and their end connections
- 1.13 Symbolic representation of pipe fittings
- 1.14 Identification of piping and ducting by color code system and abbreviations.

INTRODUCTION TO ARCHITECTURAL DRAWING**6 Hours**

- 1.15 Description of soil, RCC walls, and building plans
 - 1.16 Type of doors and windows
 - 1.17 Types of Building (residential, public, educational, industrial and commercial).
 - 1.18 Working drawings - elevation, plans and sectional views of buildings.
-

COMPUTER AIDED DRAWING

6 Hours

- 1.19 Introduction to CAD software
 - 1.19.1 Initial Screen: Title Bar, Menu Bar, Scroll Bar, Toolbar, Command Line, and Drawing Area
 - 1.19.2 Overviews: Pull Down Menus and Dialog Boxes
 - 1.19.3 Help command
 - 1.19.4 File save
 - 1.19.5 File print
 - 1.19.6 Edit
 - 1.19.7 Modify
- 1.20 Introduction to 2D CAD Fundamentals
 - 1.20.1 Points and lines
 - 1.20.2 Array
 - 1.20.3 Dots in space
 - 1.20.4 A lightening block
 - 1.20.5 Shapes
 - 1.20.6 Extending lines
 - 1.20.7 Expanding, circles and rectangles
 - 1.20.8 Circle, Arcs and Polygons
 - 1.20.9 Dimensioning
 - 1.20.10 Text
 - 1.20.11 Blocks
 - 1.20.12 Scale, Rotate, Copy and Move
 - 1.20.13 Hatching and Coloring
 - 1.20.14 Fill Command
 - 1.20.15 Layers
 - 1.20.16 Limits
 - 1.20.17 Printing & Plotting
- 1.21 Introduction to 3D CAD fundamentals (Extrusion, Cut Out, Pattern etc.)
- 1.22 Introduction to BIM software (Revit) for HVAC design and coordination.
- 1.23 Introduction to Clash detection and interdisciplinary coordination.

RECOMMENDED BOOKS:

1. Fundamental of Pipe drafting By Charles M. Thomson
 2. First Year Engineering Drawing By A. C. Parkinson
 3. Building Construction By Arrora
 4. Introduction to Auto CAD Basics (latest version)
 5. Autodesk BIM for MEP & structural engineers
 6. BIM guidebook for MEP designers by MagiCAD
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HVAC-263: ENGINEERING, ARCHITECTURAL, & COMPUTER AIDED DRAWING

INSTRUCTIONAL OBJECTIVES:

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

- 1. UNDERSTAND THE CONCEPT OF ENGINEERING & ARCHITECTURAL DRAWING AND DRAW ISOMETRIC, ORTHOGRAPHIC, SECTIONAL VIEWS AND DEVELOPMENT OF SURFACES.**
 - 1.1 Explain the role of Engineering & Architectural Drawing.
 - 1.2 Explain sectional views and their types
 - 1.3 State sectional views
 - 1.4 Explain isometric projection of a piping system
 - 1.5 Explain orthographic projection of a piping system
 - 1.6 Explain inclined and curved surfaces
 - 1.7 Describe development (laying out) of inclined and curved surfaces by parallel line, triangulation, and radial line methods.
 - 2 UNDERSTAND THE PIPES, PIPE FITTINGS, VALVES, DUCTING, PIPES/DUCTS HANGING SYSTEM AND THE SYMBOLS USED IN HVAC&R INSTALLATIONS**
 - 2.1 Explain symbols used in plumbing and HVAC&R system drawings
 - 2.2 Explain Electrical Symbols used in Engineering Drawing
 - 2.3 Explain Representation of Pipes and ducts hanging with roof and walls
 - 2.4 Explain Types of wall brackets and roof clamps
 - 2.5 Explain Pipe lines drawings, using pipe fitting symbols (single line and double line)
 - 2.6 Explain Pipe fittings, study and use of screwed, flanged and welded ends pipe connections
 - 2.7 Explain Pipes and piping system drawings
 - 2.8 Explain Ducting system drawings
 - 2.9 Explain Pipes and types of pipes like welded, seamless, concrete and ceramics
 - 2.10 Explain Valves and their types like globe, gate, check, cock, and relief etc. and their end connections
 - 2.11 Explain symbolic representation of pipe fitting
 - 2.12 Explain Identification of piping and ducting by color code system and abbreviations
 - 3. UNDERSTAND THE WORKING DRAWINGS OF BUILDING PLANS, EVALUATION, SECTION, BUILDING PLANNING AND CONSTRUCTION.**
 - 3.1 Explain the soil & its types and RCC walls
 - 3.2 Explain the types of doors and windows
 - 3.3 State the method of drawing symbols of doors and windows
 - 3.4 Explain the types of building.
 - 3.5 State the method of drawing the elevations, plans and sectional views of buildings.
 - 4. UNDERSTAND THE COMPUTER AIDED DRAWING**
 - 4.1 Explain Auto CAD software
 - 4.1.1 Explain Initial Screen: Title Bar, Menu Bar, Scroll Bar, Toolbar, Command Line, and Drawing Area
 - 4.1.2 Explain Overviews: Pull Down Menus and Dialog Boxes
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- 4.1.3 Explain Help command
 - 4.1.4 Explain File save
 - 4.1.5 Explain File print
 - 4.1.6 Explain Edit
 - 4.1.7 Explain Modify
 - 4.2 Explain the 2D CAD Fundamentals
 - 4.2.1 Explain Points and lines
 - 4.2.2 Explain Dots in space
 - 4.2.3 Explain A lightening blot
 - 4.2.4 Explain Shapes
 - 4.2.5 Explain Expanding lines, circles and rectangles
 - 4.2.6 Explain Circle, Arcs and Polygons
 - 4.2.7 Explain Dimensioning
 - 4.2.8 Explain Text
 - 4.2.9 Explain Blocks
 - 4.2.10 Explain Scale, Rotate, Copy and Move
 - 4.2.11 Explain Hatching and Coloring
 - 4.2.12 Explain Fill Command
 - 4.2.13 Explain Layers
 - 4.2.14 Explain Limits
 - 4.2.15 Explain Printing & Plotting
 - 4.3 Explain 3D CAD fundamentals
 - 4.3.1 Extrusion
 - 4.3.2 Cut Out
 - 4.3.3 Pattern etc.
 - 4.4 Explain BIM software (Revit) for HVAC design and coordination.
 - 4.5 Explain Clash detection and interdisciplinary coordination.
-

LIST OF PRACTICALS

192 Hours

On completion of this course, the trainees will be able to;

1. DRAW THE DEVELOPMENT OF DIFFERENT SURFACES.

- 1.1 Inclined and curved surfaces (layout patterns) by parallel line, triangulation and radial line methods.
- 1.2 Tee joints (round pipe tee).
- 1.3 Pipe joints (Intersecting pipes).
- 1.4 Square and rectangular ducts, truncated cone, pipes & ducts, and transition pieces etc.
- 1.5 Symbols of components/equipment used in HVAC&R Systems.

2. DRAW

- 2.1 Orthographic drawings of a piping system.
- 2.2 Isometric views of a piping system.
- 2.3 Single line piping.
- 2.4 Double line piping
- 2.5 Electrical symbols

3. DRAW PLAN, ELEVATION, AND SECTIONS OF BUILDINGS

- 3.1 Showing doors, windows and other architectural symbols etc.
- 3.2 Different types of buildings.

4. DRAW COMPUTER AIDED DRAWINGS

- 4.1 Drawing Techniques
 - 4.1.1 Setup a new file, Select Wizard, or Template
 - 4.1.2 Units selection, drawing limits and drawing aids
 - 4.2 Use of basic commands
 - 4.2.1 Arc, Circle, Ellipse, Line, Multi Line, Polyline, Rectangle, Spline, Text
 - 4.2.2 Relative and Absolute Coordinates
 - 4.2.3 Cartesian and Polar Coordinates
 - 4.2.4 Drawing Colors
 - 4.2.5 Line Types
 - 4.2.6 Blocks and Attributes
 - 4.2.7 Layers
 - 4.2.8 Hatching
 - 4.2.9 Dimensions
 - 4.2.10 Simple 3D Drawing
 - Extrusion
 - Cut Out
 - Pattern etc.
 - 4.2.11 Solid Command
 - 4.2.12 Isometric Drawing
 - 4.2.13 Inquiry Command
-

- 4.2.14 Redraw and Regain Command
- 4.2.15 Fill Command
- 4.2.16 Limits
- 4.2.17 Printing & Plotting

5. DRAW SYMBOLS FOR PIPING, PIPE FITTINGS PLUMBING, AND HVAC&R DUCTING SYSTEM

- 5.1 Identification of piping and ducting by color code system and abbreviations.
 - 5.2 To draw the diagram of piping and their fixtures.
-

HVAC-273: ADVANCE REFRIGERATION

T	P	C
3	0	3

Total contact hours:

Theory 96 hours

LEARNING OUTCOMES:

- a) The aims of the course are to help the students, to understand the advance theory of refrigeration, application of actual refrigeration system, special installations and design feature of cold storage
- b) Acquire knowledge of the different refrigeration installation, causes of food spoilage, their remedies and problems in handling cold storage.
- c) Design cold storage by means of calculations.

Part-A

- 1. CONVENTIONAL VAPOR COMPRESSION SYSTEM** 5 Hours
 - 1.1 Types of compression system.
 - 1.2 Conventional compression system using automatic expansion valve as refrigerant control.
 - 1.3 Compression system using thermostatic expansion valve as refrigerant control.
 - 1.4 Low side float valve.
 - 1.5 High side float valve .
 - 1.6 Capillary tube system
 - 1.7 Electronic expansion valve
 - 2. WATER CHILLER (AIR COOLED/WATER COOLED)** 8 Hours
 - 2.1 Double pipe
 - 2.2 Baudlot and tank type cooler.
 - 2.3 Shell and tube chiller.
 - 2.4 Dry expansion chiller.
 - 2.5 Spray type chiller.
 - 2.6 Direct and indirect system
 - 2.7 Secondary Refrigerants and Antifreeze solutions
 - Water
 - Brine
 - Mixture of Ethylene glycol & Water
 - Mixture of Propylene glycol & Water
 - 2.8 Cryogenic fluids.
 - 2.9 Cryogenic applications.
 - 3. DEFROSTING.** 8 Hours
 - 3.1 Defrosting intervals.
 - 3.2 Methods of defrosting.
 - 3.2.1 Water defrosting.
 - 3.2.2 Electric defrosting.
 - 3.2.3 Hot gas defrosting.
 - 3.2.4 Re-evaporator coils.
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- 3.2.5 Defrosting multiple evaporator systems.
- 3.2.6 Reverse cycle defrosting.
- 3.2.7 Heat bank defrosting.
- 3.2.8 Vapor defrosting.

4. **METHODS OF OBTAINING ULTRA-LOW TEMPERATURE** 6 Hours
 - 4.1 Cascade System
 - 4.2 Multi stage (booster) compression
 - 4.3 Two stage and multistage system.
 - 4.4 Multi temperature system.
 - 4.5 Intercooler.

5. **TRANSPORT REFRIGERATION AND AIR CONDITIONING.** 5 Hours
 - 5.1 Truck refrigeration
 - 5.2 Marine refrigeration
 - 5.3 Automobile (car) air-conditioning.
 - 5.4 Railway car air conditioning.
 - 5.5 Air craft air conditioning.

6. **COMMERCIAL SYSTEM APPLICATION.** 6 Hours
 - 6.1 Reach-in-cabinet.
 - 6.2 Walk-in-cabinet.
 - 6.3 Florist cabinet.
 - 6.4 Display cases, single duty, double duty cases.
 - 6.5 Ice cream cabinet.
 - 6.6 Automatic Ice Maker and its types.
 - 6.7 Vending Machine.
 - 6.8 Application for:
 - food and beverage industry
 - Restaurant, Mall and Catering.
 - Hospital and Pharmaceutical Industry

7. **FOOD PRESERVATION.** 8 Hours
 - 7.1 Principles of food preservation.
 - 7.2 Deterioration and spoilage.
 - 7.3 Enzymes.
 - 7.4 Micro-organisms.
 - 7.5 Bacteria.
 - 7.6 Yeasts.
 - 7.7 Molds.
 - 7.8 Control of spoilage agents
 - 7.9 Preservation of food by refrigeration (low temperature) and by high temperature.

Part – B

8. **REFRIGERATED STORAGE.** 8 Hours
 - 8.1 Refrigerated storage
 - 8.2 Storage conditions.
 - 8.3 Storage temperature.
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8.4	Humidity and air motion.	
8.5	Humidity control via desiccant system	
8.6	Mixed storage.	
8.7	Product condition on entering storage.	
8.8	Product chilling and pre-cooling.	
8.9	Freezing and frozen storage.	
9.	FREEZING METHODS.	6 Hours
9.1	Freezing methods and preparing food stuff before preservation.	
9.2	Air blast freezing.	
9.3	Indirect contact freezing.	
9.4	Immersion freezing.	
9.5	Comparison between Quick freezing and Sharp freezing	
9.6	Packing material and containers.	
10.	FOOD PRODUCTS.	6 Hours
10.1	Cold storage practice for vegetables.	
10.2	Cold storage practice for fruits.	
10.3	Cold storage practice for meat, fish, poultry, milk and their products.	
11.	FACTORS DETERMINING THE LOAD.	7 Hours
11.1	Cooling load	
11.2	Equipment running time.	
11.3	Cooling load calculations.	
11.4	Wall gain load.	
11.5	Air change load.	
11.6	Product load.	
11.7	Miscellaneous load.	
12.	COOLING LOAD CALCULATIONS FOR COLD STORAGES	6 Hours
12.1	Factors determining the wall gain load.	
12.2	Determination of "U" factor.	
12.3	Temperature differential across cold storage walls.	
12.4	Temperature differential across ceilings and floors.	
12.5	Effect of solar radiation.	
12.6	Calculating the wall gain load.	
12.7	Calculating the air change load.	
12.8	Vapor pressure and vapor transmission	
13.	PRODUCT LOAD.	6 Hours
13.1	Calculating the product loads.	
13.2	Chilling rate factor.	
13.3	Product freezing and storage.	
13.4	Respiration heat.	
14.	MISCELLANEOUS LOAD.	3 Hours
14.1	Calculating the miscellaneous load.	
14.2	Use of safety factor.	
14.3	Short method load calculations.	

- 14.4 Metric calculation.
- 14.5 Customary problems.

- 15. Sustainable Practices & Emerging technologies in Refrigeration** 6 Hours
 - 15.1 Low-GWP Refrigerants and Alternatives
 - 15.2 Energy-Efficient (Green) Technologies in Refrigeration Systems
 - 15.3 Integration of Renewable Energy Sources
 - 15.4 Life Cycle Assessment (LCA) for Refrigeration Systems
 - 15.5 Waste Heat Recovery
 - 15.6 Sustainable Cold Chain Management for Food and Pharmaceuticals
 - 15.7 Autonomous refrigeration units with GPS tracking
 - 15.8 Electric and hybrid systems for Cold chain trucks and vehicles
 - 15.9 Thermoelectric cooling (emerging alternative)

REFERENCE BOOKS

- 1. Principles of Refrigeration by R.J.Dossat.
 - 2. Modern Refrigeration and Air Conditioning by Althouse.
 - 3. ASHRAE Handbook – Fundamentals (Latest Version).
 - 4. ASHRAE Handbook – Refrigeration (Latest Version).
 - 5. Refrigeration & Air conditioning (A text book) by R.S. Khurmi, and J.K. Gupta.
-

HVAC-273: ADVANCE REFRIGERATION

INSTRUCTIONAL OBJECTIVES:

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

Part-A

- 1. UNDERSTAND THE CONVENTIONAL COMPRESSION SYSTEM**
 - 1.1 Enlist the type of compression system.
 - 1.2 Explain conventional compression system using automatic expansion valves as refrigerant control.
 - 1.3 Explain conventional compression system using thermostatic expansion valve as refrigerant control.
 - 1.4 Explain conventional compression system using electronic expansion valve
 - 1.5 Explain low and high side float valve with Rotary compressor.
 - 1.6 Explain electronic expansion valve

 - 2. UNDERSTAND THE PRINCIPLE OF OPERATION, CONSTRUCTION AND UTILIZATION OF WATER CHILLER IN COMMERCIAL AND INDUSTRIAL REFRIGERATION.**
 - 2.1 Enlist the type of water chiller.
 - 2.2 Explain the working principle of double pipe water chiller.
 - 2.3 Explain the working principle of Baudelot and tank type coolers.
 - 2.4 Explain the working principle/operation of shell and tube chiller.
 - 2.5 Explain the working principle/operation of dry expansion chiller.
 - 2.6 Explain the working principle/operation of spray type chiller.
 - 2.7 Distinguish between direct and in direct system.
 - 2.8 Define secondary refrigerants.
 - 2.9 Define anti-freezing solution.
 - 2.10 State the use of secondary refrigerants and antifreeze solutions
 - Water
 - Brine
 - mixture of ethylene glycol and water
 - mixture of propylene glycol and water
 - 2.11 Describe cryogenic fluid.
 - 2.12 Explain application of cryogenics.
 - Medical sector (Vaccine storage)
 - Food sector
 - Others

 - 3. UNDERSTAND THE METHODS OF DEFROSTING**
 - 3.1 Explain the purpose of defrosting.
 - 3.2 Identify the different types of defrosting method.
 - 3.3 Explain water defrosting method
 - 3.4 Explain electric defrosting method.
 - 3.5 Explain hot gas defrosting method.
 - 3.6 Describe re-evaporator coils.
 - 3.7 Explain defrosting multiple evaporator system.
 - 3.8 Illustrate reverse cycle defrosting.
 - 3.9 State heat bank defrosting.
 - 3.10 State vapor defrosting.
-

4. UNDERSTAND THE METHODS OF ULTRA-LOW TEMPERATURE

- 4.1 Explain Cascade system.
- 4.2 Explain multistage (booster) compression.
- 4.3 Explain the two stage and multistage system.
- 4.4 Explain the multi temperature system.
- 4.5 Explain Intercoolers.

5. UNDERSTAND THE DIFFERENT TYPES OF TRANSPORT REFRIGERATION AND AIR CONDITIONING SYSTEMS.

- 5.1 State the purpose of transport refrigeration and air-conditioning.
- 5.2 Explain truck refrigeration.
- 5.3 Explain marine refrigeration.
- 5.4 Explain automobile (car) air conditioning.
- 5.5 Explain railway car air conditioning.
- 5.6 Explain air craft air conditioning.

6. UNDERSTAND THE USE OF COMMERCIAL SYSTEM APPLICATION

- 6.1 Enlist commercial type of refrigerating units.
- 6.2 Explain the use and function of reach-in cabinet.
- 6.3 Explain the use and function of walk-in cabinet.
- 6.4 State the use and function of florist cabinet.
- 6.5 Differentiate between single duty display cases and double duty display cases.
- 6.6 Identify the different components of ice cream cabinet.
- 6.7 Identify different component of automatic ice maker.
- 6.8 Explain vending machine.
- 6.9 Explain application in following industries:
 - food and beverage industry
 - Restaurant, Mall and Catering.
 - Hospital and Pharmaceutical Industry

7. UNDERSTAND THE FOOD PRESERVATION METHODS.

- 7.1 Describe the principles and importance of food product preservation.
- 7.2 Describe deterioration and spoilage of food.
- 7.3 Define enzymes, micro-organisms, bacteria, yeast and mold.
- 7.4 Explain the control of spoiling agents.
- 7.5 Preservation of food by refrigeration (low temperature) and by high temperature

Part-B

8. UNDERSTAND THE REFRIGERATED STORAGE TECHNIQUES.

- 8.1 Explain refrigerated space, storage conditions, storage temperature, humidity and air motion.
 - 8.2 Enlist the storage conditions of meat product.
 - 8.3 Enlist the storage temperature of different vegetables.
 - 8.4 Describe humidity and air motion.
 - 8.5 Describe Humidity control via desiccant system
 - 8.6 Describe Mixed storage.
 - 8.7 Describe Product condition on entering storage.
 - 8.8 Describe Product chilling and pre-cooling.
 - 8.9 Describe Freezing and frozen storage
-

- 9 UNDERSTAND THE FREEZING METHODS, PREPARING FOOD STUFF BEFORE PRESERVATION AND PACKING MATERIALS.**
- 9.1 Enlist the methods of freezing and preparing of food product before preservation.
 - 9.2 Explain air blast freezing.
 - 9.3 State indirect contact freezing.
 - 9.4 State immersion freezing.
 - 9.5 Differentiate between quick freezing and sharp freezing.
 - 9.6 Explain packing materials and containers.
- 10 UNDERSTAND THE COLD STORAGE PRACTICES FOR DIFFERENT TYPES OF VEGETABLE, FRUITS, MEATS, MILK AND THEIR PRODUCTS.**
- 10.1 Explain the methods of cold storage Practice for vegetable.
 - 10.2 Explain the methods of cold storage Practice for fruits.
 - 10.3 Explain the methods of cold storage Practice for meat/poultry.
 - 10.4 Explain the methods of cold storage Practice for fisheries and milk products.
- 11. UNDERSTAND THE FACTORS FOR DETERMINING THE HEAT LOAD.**
- 11.1 Enlist the factors while calculating cooling load of any type of cold storage.
 - 11.2 State equipment running time.
 - 11.3 Explain the wall gain load.
 - 11.4 Explain the air change load.
 - 11.5 Explain the product load.
 - 11.6 Explain the miscellaneous load.
- 12. CALCULATE THE COOLING LOAD FOR COLD STORAGE**
- 12.1 Identify the factors determining the wall gain load.
 - 12.2 Calculate U factor.
 - 12.3 Explain the temperature differential across cold storage wall.
 - 12.4 Explain the temperature differential across ceiling and floor.
 - 12.5 Explain the effect of solar radiation.
 - 12.6 Calculate the wall gain radiation.
 - 12.7 Calculate the air gain load.
 - 12.8 Explain vapor pressure and vapor transmission
- 13. CALCULATE THE PRODUCT LOAD.**
- 13.1 Describe how to calculate product load.
 - 13.2 Describe chilling rate factor.
 - 13.3 Describe product freezing and storage
 - 13.4 Explain respiration heat.
- 14. CALCULATE THE COOLING LOAD OF MISCELLANEOUS PRODUCTS OF COLD STORAGE**
- 14.1 Calculate the miscellaneous load.
 - 14.2 Explain the short method load calculations.
 - 14.3 Apply metric system for calculating the cooling load.
- 15. SUSTAINABLE PRACTICES & EMERGING TECHNOLOGIES IN REFRIGERATION**
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- 15.1 List down Low-GWP Refrigerants and Alternatives
 - 15.2 Briefly write about Energy-Efficient Technologies in Refrigeration Systems
 - 15.3 Describe Integration of Renewable Energy Sources
 - 15.4 Describe Life Cycle Assessment (LCA) for Refrigeration Systems
 - 15.5 Describe Waste Heat Recovery
 - 15.6 Explain Sustainable Cold Chain Management for Food and Pharmaceuticals
 - 15.7 What are autonomous refrigeration units with GPS tracking
 - 15.8 Describe electric and hybrid systems for trucks and vehicles
 - 15.9 Describe thermoelectric cooling (emerging alternative)
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HVAC-283: HVAC&R WORKSHOP PRACTICE - II

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Total contact Hours:

Theory 32 Hours

Practical 192 Hours

LEARNING OUTCOMES:-

1. At the end of the course, the students will have acquired the ability of repair, servicing, maintenance and installation of parts used in domestic refrigeration machines and air conditioning equipment.
2. Trouble shooting in refrigeration machines and suggest their remedies.
3. Understand electric circuits of refrigeration machines and window air conditioners

- 1. REPAIRING, SERVICING AND RECHARGING OF REFRIGERATION EQUIPMENT** 5 Hours
 - 1.1 Mechanical parts of domestic refrigeration machines.
 - 1.2 Replacing & Installation of parts
 - 1.3 Leak detection methods
 - 1.4 Evacuation methods
 - 1.5 Re-charging of Compressor Oil & Charging of Refrigerant Gas
 - 2. CONSTRUCTION FEATURES OF CABINET OF REFRIGERATION & AIR CONDITIONING EQUIPMENT** 5 Hours
 - 2.1 Refrigerator body
 - 2.2 Deep freezer
 - 2.3 Water cooler
 - 2.4 Display cabinet and its types.
 - 2.5 Window air conditioner
 - 2.6 Split air conditioner – Heat pump.
 - 2.7 Automobile Air conditioning Unit
 - 3. DRAWING ELECTRICAL CIRCUITS OF REFRIGERATION AND AIR CONDITIONING EQUIPMENT** 6 Hours
 - 3.1 Basic control and power circuit
 - 3.2 AC single phase motor starter circuit
 - 3.3 Domestic refrigerator
 - 3.4 Deep freezer
 - 3.5 Display Cabinet
 - 3.6 Domestic window type air conditioner
 - 3.7 Split type (heat pump) air conditioner
 - 3.8 Multiple (hot and cold) water cooler
 - 3.9 Ice cube maker and ice cream freezing dispenser
 - 3.10 Inverter split air conditioner
 - 4. REFRIGERANT RECOVERY, RECYCLING & RECLAIMING** 6 Hours
 - 4.1 Chloro-fluoro carbons (CFC's), Hydro-fluoro carbons (HFC's) hydro-chloro-fluoro carbons (HCFC's), Hydro-Carbons (HC's) and the ozone layer
 - 4.2 Recovery, recycling, reclaiming procedure for refrigerants (HCFC's, HC's)
 - 4.3 Refrigerant recovery equipment
 - 4.4 Refrigerant cycling equipment
 - 4.5 Safety and standards for CFC's, HCFC's and HC's refrigerants
 - 5. TROUBLESHOOTING OF REFRIGERATION SYSTEMS** 7 Hours
 - 5.1 Electrical Faults
 - 5.1.1 Compressor does not start
 - 5.1.2 Compressor operates intermittently
 - 5.1.3 Compressor starts and runs but cycles on protector
 - 5.1.4 Starting capacitor burnt out
 - 5.1.5 Running capacitor burnt out
 - 5.1.6 Motor controls defective
 - Low side pressure motor control
-

- High side pressure safety motor control
- 5.1.7 Relays burnt-out
- 5.1.8 Defective heater
- 5.1.9 Defective switches
- 5.1.10 Defective Overload Protector

5.2 Mechanical Faults

- 5.2.1 Shortage of Refrigerant
- 5.2.2 Leakage
- 5.2.3 Moisture in the refrigerant circuit
- 5.2.4 Restriction in Refrigerant Flow Control
- 5.2.5 Faulty gasket seal
- 5.2.6 Stuck motor compressor
- 5.2.7 Presence of oil in the evaporator

6. TROUBLE SHOOTING AND REMEDIES

3 Hours

- 6.1 Compressor windings
- 6.2 Burn-out overload, fan motors and relays
- 6.3 Damage of thermostats & timer

RECOMMENDED BOOK AND SOFTWARE(S)

1. Althouse, A., Turnquist C. and Bracciano. A Modern Refrigeration and Air conditioning. The Goodheart. Willcox Co., Inc., U.S.A.
2. R.J. Dossat, Principles of Refrigeration. John Wiley and Sons Inc., Tokyo Japan
3. Harris, N.C., Conde, D.F. Modern Air Conditioning. McGraw Hill Book Co., USA
4. Mcquiston F.C., Parker, J.D. Heating, Ventilating, and Air conditioning Analysis and Design. John Wiley and Sons, Inc., USA
5. Schmaltzier, Gerald and Eveling. Basic Air conditioning. Hiayden Book Co., Inc., USA
6. HVAC Simulator (HVACSim / HVAC Simulator Pro)
7. ESCO Institute HVACR Virtual Lab Simulations

HVAC-283: HVAC&R WORKSHOP PRACTICE - II

INSTRUCTIONAL OBJECTIVES:

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

- 1. UNDERSTAND THE PROCEDURE OF REPAIRING, SERVICING AND CHARGING THE REFRIGERATION EQUIPMENT**
 - 1.1 Enlist mechanical parts of a refrigerator
 - 1.2 Describe the mechanical parts of a refrigerator
 - 1.3 Explain the procedure of replacing different parts of domestic refrigeration machines
 - 1.4 Describe leak detection methods.
 - 1.5 Explain Evacuation methods
 - 1.6 Explain Charging methods of domestic refrigeration machines
 - 1.7 Explain the procedure of oil charging in domestic refrigeration machines.

 - 2 UNDERSTAND THE CABINET CONSTRUCTION OF THE REFRIGERATION & AIR CONDITIONING EQUIPMENT**
 - 2.1 Explain the constructions of refrigerator body
 - 2.2 Explain the construction of deep-freezer body
 - 2.3 Explain the construction of different display cabinet
 - 2.4 Explain the construction of window type air conditioner
 - 2.5 Explain the construction of a split type air conditioner
 - 2.6 Explain the constructions of water cooler
 - 2.7 Explain the construction of Automobile Air Conditioning Unit

 - 3. DRAWING ELECTRICAL CIRCUITS OF REFRIGERATION AND AIR CONDITIONING EQUIPMENT**
 - 3.1 Draw and explain basic control and power circuit
 - 3.2 Draw and explain AC single phase motor starter circuit
 - 3.3 Draw and explain electric circuit diagram of domestic refrigerator
 - 3.4 Draw and explain electric circuit diagram of deep freezer
 - 3.5 Draw and explain electric circuit diagram of multiple (hot and cold) water cooler
 - 3.6 Draw and explain electric circuit diagram of a display cabinet
 - 3.7 Draw and explain electric circuit diagram of domestic window type air conditioner
 - 3.8 Draw and explain electric circuit diagram of split type (heat pump) air conditioner
 - 3.9 Draw and explain electric circuit diagram of ice cube maker and ice cream freezing dispenser
 - 3.10 Draw and explain circuit diagram of split air conditioner (inverter type)

 - 4. UNDERSTAND THE REFRIGERANT RECOVERY, RECYCLING & RECLAIMING METHODS**
 - 4.1 Describe the effect of Chloro-fluoro carbons (CFC's), Hydro-fluoro carbons (HFC's) hydro-chloro-fluoro carbons (HCFC's), Hydro-Carbons (HC's) refrigerants on the ozone layer, GWP and ODP.
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- 4.2 Explain the proper procedures to recover, recycle, reclaim Hydro-Chlorofluorocarbons (HCFC's) and Hydrocarbons (HC's) refrigerants.
- 4.3 Identify and describe various types of refrigerant recovery and recycling equipment and their uses
- 4.4 Enlist and explain the safety and standards followed for HCFC's and HC's regarding recovery, recycle and reclaim.

5. TROUBLE SHOOTING OF REFRIGERATION & AIRCONDITIONING SYSTEMS

- 5.1 Explain the types of expected electrical faults relating to;
 - 5.1.1 Compressor does not start
 - 5.1.2 Compressor operates intermittently
 - 5.1.3 Compressor starts and runs but cycles on protector
 - 5.1.4 Starting capacitor burnt out
 - 5.1.5 Running capacitor burnt out
 - 5.1.6 Motor controls defective
 - Low side pressure motor control
 - High side pressure safety motor control
 - 5.1.7 Relays burnt-out
 - 5.1.8 Defective heater
 - 5.1.9 Defective switches
 - 5.1.10 Defective Overload Protector
- 5.2 Explain the types of expected mechanical faults relating to;
 - 5.2.1 Shortage of refrigerant
 - 5.2.2 Leakage
 - 5.2.3 Moisture in the refrigerant circuit
 - 5.2.4 Restriction in Refrigerant Flow Control
 - 5.2.5 Faulty gasket seal
 - 5.2.6 Stuck motor compressor
 - 5.2.7 Presence of oil in the evaporator

6. UNDERSTAND AND DIAGNOSE THE COMMON TROUBLES IN THE REFRIGERATION EQUIPMENT

- 6.1 Explain the various causes to burnout the compressor windings.
 - 6.2 Explain the various common causes to burnout the overload, fan motor and relays.
 - 6.3 Explain the causes of damage to thermostat & timer
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HVAC-283: HVAC&R WORKSHOP PRACTICE - II

Total Practical Hrs- 192 Hours

LEARNING OUTCOMES:

1. To provide practice of refrigerating and air conditioning equipment repair, maintenance, service and their installations.
2. To locate trouble shooting in refrigerating and air conditioning equipment and suggest their remedies.

To acquaint the students with the electric circuits of refrigeration and air conditioning equipment.

LIST OF PRACTICALS

192 Hours

On completion of this course the trainees will be able to;

1. REFRIGERANT RECOVERY METHODS 15 Hours
 - 1.1 Recover liquid refrigerant (CFC, HFC, HCFC, HC, etc.) from a sealed system using a recovery unit.
 - 1.2 Recover vapor refrigerant (CFC, HFC, HCFC, HC, etc.) from a sealed system using a recovery unit.
 - 1.3 Recover refrigerant (CFC, HFC, HCFC, HC, etc.) using the system-dependent passive recovery method.
 - 1.4 Evacuate refrigerant (CFC, HFC, HCFC, HC, etc.) into an approved external recovery cylinder.
 2. REFRIGERATION PROJECT 45 Hours
 - 2.1 Identify refrigeration system components.
 - 2.2 Prepare system layout drawings for a refrigeration project.
 - 2.3 Prepare a bill of materials for the refrigeration project.
 - 2.4 Recover refrigerant from the refrigeration system.
 - 2.5 Replace compressor oil in a hermetic system, where required.
 - 2.6 Assemble project tubing and electrical wiring.
 - 2.7 Perform pressure and leak testing of the refrigeration system.
 - 2.8 Evacuate the refrigeration system.
 - 2.9 Charge the required quantity of refrigerant by weight.
 - 2.10 Commission the refrigeration system after refrigerant charging.
 - 2.11 Measure and record system operating temperatures and pressures.
 - 2.12 Install, service, test, and adjust the following metering devices:
 - 2.12.1 Capillary tube
 - 2.12.2 Automatic Expansion Valve (AEV)
 - 2.12.3 Thermostatic Expansion Valve (TXV)
 - 2.13 Install, service, test, and adjust the following pressure controls:
 - 2.13.1 Low-pressure control
 - 2.13.2 Dual-pressure control
 - 2.14 Install, service, and test thermostats and solenoid valves to create a pump-down system.
 3. SERVICE PROCEDURES OF REFRIGERATION SYSTEMS 60 Hours
 - 3.1 Wire an inverter split air conditioning system.
 - 3.2 Check the refrigerant charge without using pressure gauges.
 - 3.3 Add compressor oil to a hermetic refrigeration system.
 - 3.4 Wire an ice cube maker and an ice cream freezer.
 - 3.5 Clean and flush a refrigeration system after compressor burnout.
 - 3.6 Wire a refrigerated display cabinet.
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- 3.7 Replace an evaporator fan motor.
- 3.8 Replace a condenser fan motor.
- 3.9 Replace a capillary tube in a refrigeration system.
- 3.10 Replace the filter-drier in a hermetic refrigeration system.
- 3.11 Charge a refrigeration system with the specified refrigerant.
- 3.12 Perform a leak test on a refrigeration system.
- 3.13 Service a conventional refrigeration system.
- 3.14 Wire a multiple hot-and-cold water cooler.
- 3.15 Test and operate a capacitor-start, capacitor-run hermetic compressor motor.
- 3.16 Replace a hermetic compressor.
- 3.17 Remove and install refrigerator door hardware.
- 3.18 Diagnose and troubleshoot faults in a defrost system.
- 3.19 Wire a domestic refrigerator.
- 3.20 Wire a deep freezer.
- 3.21 Inspect and test all electrical components of a refrigeration system.

4. TROUBLESHOOTING OF REFRIGERATION SYSTEMS USING COMPUTER SIMULATION SOFTWARE 48 Hours

- 4.1 Analyze, diagnose, and troubleshoot refrigeration system faults using computer simulation software by interpreting system behavior, identifying faults, and documenting repair activities.

The following simulated fault conditions shall be analyzed:

- 4.1.1 Diagnose refrigerant undercharge.
 - 4.1.2 Diagnose refrigerant overcharge.
 - 4.1.3 Diagnose a defective TXV power element.
 - 4.1.4 Diagnose a TXV stuck open.
 - 4.1.5 Diagnose a clogged filter-drier.
 - 4.1.6 Diagnose an excessively dirty evaporator coil.
 - 4.1.7 Diagnose incorrectly installed evaporator fan blades.
 - 4.1.8 Diagnose restricted condenser airflow.
 - 4.1.9 Diagnose a compressor that fails to start.
 - 4.1.10 Diagnose defective compressor valves.
 - 4.1.11 Diagnose a CPR valve stuck closed.
 - 4.1.12 Diagnose air and moisture contamination in the system.
 - 4.1.13 Diagnose an open compressor run winding.
 - 4.1.14 Diagnose a compressor start winding shorted to ground.
 - 4.1.15 Diagnose shorted compressor windings.
 - 4.1.16 Diagnose a compressor overload protector stuck open.
 - 4.1.17 Diagnose a shorted compressor run capacitor.
 - 4.1.18 Diagnose an open compressor start capacitor.
 - 4.1.19 Diagnose an open start relay coil.
 - 4.1.20 Diagnose an open condenser fan motor winding.
 - 4.1.21 Diagnose an open evaporator fan motor winding.
 - 4.1.22 Diagnose an open defrost timer motor winding.
 - 4.1.23 Diagnose a defrost timer contact stuck open.
 - 4.1.24 Diagnose a defrost thermostat stuck in the terminate position.
 - 4.1.25 Diagnose an open defrost heater element.
 - 4.1.26 Diagnose an open hot gas valve solenoid coil.
 - 4.1.27 Diagnose an open liquid line solenoid coil.
 - 4.1.28 Diagnose a thermostat/pressure control stuck open.
 - 4.1.29 Diagnose a high-pressure switch stuck open.
 - 4.1.30 Diagnose a defective circuit breaker.
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5. TESTING PROCEDURES OF REFRIGERATOR AND AIR CONDITIONER COMPONENTS 24 Hours

5.1 Mechanical Components

Test the following mechanical components and submit findings:

5.1.1 Compressor motor components

5.1.2 Condensers

5.1.3 Evaporators

5.1.4 Piping accessories

5.1.5 Humidity control devices

5.1.6 Valves

5.1.7 Accumulators

5.1.8 Oil separators

5.1.9 Pressure regulators

5.1.10 Temperature regulators

5.1.11 Mufflers

5.1.12 Gas kit seals

5.1.13 Presence of oil in the evaporator

5.2 Electrical Components

Test the following electrical components and submit findings:

5.2.1 Timers

5.2.2 Temperature controls

5.2.3 Fan motors

5.2.4 Switches

5.2.5 Heaters

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کل وقت 20 گھنٹے

نصاب سال سوئم

حصہ اول اسلامیات

حصہ دوم مطالعہ پاکستان

موضوعات:

1- قرآن مجید:

سورۃ الفاتحہ، آیت الکرسی، سورۃ البقرہ کی آخری آیات از امن الرسول ﷺ تا آخر سورۃ اخلاق مع ترجمہ و تشریح

2- دس منتخب احادیث کا ترجمہ (تشریح)

() بنی الاسلام علی خمس شہادت انا لا اله الا الله لمراقلم الصلوٰتہ و ایتا الزکوٰۃ و حج البيت و صوم

رمضان

() الدین النصیحتہ

() المنشاء موتمن

() للمومن علی المومن سنت خصال يعود ماذا مرض و تزہدہ اذا مات و یحببہ اذا دعا

() لیسلم علیہ اذا لقیہ و لیثمتہ اذا عطس و فصیحلہ اذا غاب او شہد

() لا تخن من خانک

() لا یدخل الجنۃ قاتع

() ان الله حرم علیکم عقوق المہات و اضاعتہ المال

() لیسر او لا تعسر او لا تنفر

() ذاق طعم الايمان من مرضی باللہ و با الا سلام دینا بمحمد نبیا

() افضل الذکر لا اله الا الله

3- حقوق و فرائض:

حصول تعلیم بطور فرض، والدین اور اولاد کے حقوق و فرائض، ہمسایہ کے حقوق، بچوں کے حقوق، عورتوں کے حقوق، بزرگ

شہریوں کے حقوق، محنت افراد کے حقوق۔

4- اسلام کی اخلاقی اقدار:

صبر و استقلال، غفور و درگزر، ایفائے عہد، اخوت، ایثار و قربانی۔

تدریس مقاصد

قرآن حکیم:

عمومی مقاصد: منتخب سورتوں اور آیات کی روشنی میں اسلام کے بنیادی مقاصد اور عبادات جان سکے

خصوصی مقاصد: طالب علم اس قابل ہو جائے گا کہ۔

سورة الفاتحہ، آیت لکری، سورة بقرہ کی آخری آیات ازمن الرسول سے اور سورة اخلاق کا ترجمہ و تشریح کر سکے

طالب علم درج ذیل کا مفہوم بیان کر سکے

() رب العالمین صرف اللہ تعالیٰ ہے

() اللہ رحم کرنے والا ہے

() قیامت کے دن بادشاہی اللہ کی ہوگی

() عبادات اور استعانت کا حقدار صرف اللہ ہے

() طالب علم درج ذیل کا مفہوم بیان کر سکے

() اللہ پاک ہر عیب سے پاک ہے

() اللہ کے اسمائے حسنہ حق اور قیوم ہیں

() تمام انبیاء پر ایمان لانا ضروری ہے

() رسول، ملائکہ، کتب، سماویہ، پر ایمان لانا فرض ہے

() اطاعت حقیقی صرف اللہ کے لیے ہے

() اسلامی احکامات پر عمل کرنا انسانی بساط میں ہے

() کفر کو اللہ کی مدد کے بغیر شکست نہیں دی جاسکتی

() اللہ ایک ہے

() اللہ کسی کا محتاج نہیں نہ اس کا کوئی شریک ہے

منتخب احادیث:

عمومی مقصد: احادیث کی روشنی میں اسلامی تعلیمات پر عمل پیرا ہو سکے

خصوصی مقاصد:

- () احادیث کا ترجمہ بیان کر سکے
 - () احادیث کی تشریح کر سکے
 - () معاشرتی اور انفرادی زندگی میں احادیث سے رہنمائی حاصل کر سکے
- حقوق و فرائض:

عمومی مقاصد:

- () اسلامی معاشرے کا ایک اچھا فرد بن سکے

خصوصی مقاصد:

- () والدین کے حقوق و فرائض بیان کر سکے
- () ہمسایوں کے حقوق بیان کر سکے
- () بچوں کے حقوق بیان کر سکے
- () عورتوں کے حقوق کی پاسداری کر سکے
- () بزرگ شہریوں کے حقوق کا خیال رکھ سکے
- () محنت حضرات کے حقوق جان سکے اور ان کے حقوق کی پاسداری کر کے انہیں معاشرے کا ایک مفید فرد بنایا جاسکے
- () اسلام میں حقوق و فرائض کی آگاہی کی صورت میں اپنے اندر خدمت خلق کا جذبہ پیدا کر سکے

اسلامی اقدار:

عمومی مقاصد:

- () طالب علم جان سکے گا کہ تعلیم کا مقصد حسن اخلاق سے متصف ہونا ہے

خصوصی مقاصد:

- () اخلاق کے معنی و مفہوم کو بیان کر سکے
- () اسلام میں حسن و اخلاق کی اہمیت بیان کر سکے
- () قرآن و سنت کی روشنی میں صبر و استقلال کی اہمیت بیان کر سکے
- () ایقائے عہد کی اہمیت بیان کر سکے
- () اخوت کے معنی و مفہوم بیان کر سکے
- () اخوت اسلامی کی اہمیت بیان کر سکے

() اسلام کی اعلیٰ اقدار کو اپنا کر مثالی معاشرہ پیدا کر سکے

نصاب (سال سوئم)

GEN 301

ٹی پی سی

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کل وقت 12 گھنٹے

مطالعہ پاکستان

حصہ دوئم

موضوعات:

- () قیام پاکستان
- () باؤنڈری کمیشن
- () ریڈ کلف ایوارڈ
- () تقسیم بنگال
- () تقسیم پنجاب
- () مسئلہ مہاجرین
- () ریاست کا الحاق
- () ریاست جموں کشمیر
- () نہری پانی کا تنازعہ
- () قرارداد پاکستان
- () علماء کے بایس نکات
- () 1956-1962 اور 1973 کے دساتیر کی اسلامی / انسانی حقوق کی دفعات (8 تا 28)۔
- () اقلیتوں کے حقوق۔ دیگر محروم طبقات کے حقوق
- () پاکستان کا محل وقوع اور اسکی جغرافیائی اہمیت۔ GSP+ کا تعارف اور عملی طریقہ کار
- () قدرتی وسائل (تیل، گیس، کوئلہ)

مطالعہ پاکستان (حصہ دوم)
قیام پاکستان

تدریس مقاصد:

عمومی مقاصد:

() قیام پاکستان کے بعد درپیش مسائل سے آگاہی حاصل کرے اور بیان کرے

خصوصی مقاصد:

() باؤنڈری کمیشن تشکیل اور اس کے فرائض بیان کر سکے

() ریڈ کلف اور اس کے ایوارڈ کے بارے میں بیان کر سکے

() بنگال اور کلکتہ کی تقسیم کی وجوہات بیان کر سکے

() پنجاب کی تقسیم کی تفصیل بیان کر سکے

() مہاجرین کی آمد سے جو مسائل پیدا ہوئے انہیں بیان کر سکے

() ریاستوں کے الحاق کے بارے میں تفصیل بیان کر سکے

() ریاست جموں کشمیر کے بارے میں بیان کر سکے

() نہری پانی کے تنازعہ کو بیان کر سکے

() قرارداد مقاصد کی تفصیلات بیان کر سکے

() 22 علماء کے متفقہ اسلامی نکات بیان کر سکے

() 1973 کے آئین میں انسانی حقوق کی دفعات (28-8)۔ اقلیتوں کے حقوق اور دیگر محروم طبقات کے حقوق کے بارے میں

جان سکے

() قیام پاکستان کے بعد نفاذ اسلام کی کوششوں کو بیان کر سکے

() پاکستان کے محل وقوع اور اس کی جغرافیائی اہمیت بیان کر سکے اور GSP+ کے تعارف اور عملی طریقہ کار بیان کر سکے

() پاکستان میں قدرتی وسائل (تیل، گیس، کوئلہ) کے بارے میں بیان کر سکے

خصوصی مقاصد:

- () احادیث کا ترجمہ بیان کر سکے
 - () احادیث کی تشریح کر سکے
 - () معاشرتی اور انفرادی زندگی میں احادیث سے رہنمائی حاصل کر سکے
- حقوق و فرائض:

عمومی مقاصد:

- () اسلامی معاشرے کا ایک اچھا فرد بن سکے

خصوصی مقاصد:

- () والدین کے حقوق و فرائض بیان کر سکے
- () ہمسایوں کے حقوق بیان کر سکے
- () بچوں کے حقوق بیان کر سکے
- () عورتوں کے حقوق کی پاسداری کر سکے
- () بزرگ شہریوں کے حقوق کا خیال رکھ سکے
- () محنت حضرات کے حقوق جان سکے اور ان کے حقوق کی پاسداری کر کے انہیں معاشرے کا ایک مفید فرد بنایا جاسکے
- () اسلام میں حقوق و فرائض کی آگاہی کی صورت میں اپنے اندر خدمت خلق کا جذبہ پیدا کر سکے

اسلامی اقدار:

عمومی مقاصد:

- () طالب علم جان سکے گا کہ تعلیم کا مقصد حسن اخلاق سے متصف ہونا ہے

خصوصی مقاصد:

- () اخلاق کے معنی و مفہوم کو بیان کر سکے
- () اسلام میں حسن و اخلاق کی اہمیت بیان کر سکے
- () قرآن و سنت کی روشنی میں صبر و استقلال کی اہمیت بیان کر سکے
- () ایقائے عہد کی اہمیت بیان کر سکے
- () اخوت کے معنی و مفہوم بیان کر سکے
- () اخوت اسلامی کی اہمیت بیان کر سکے

() اسلام کی اعلیٰ اقدار کو اپنا کر مثالی معاشرہ پیدا کر سکے

نصاب (سال سوئم)

GEN 301

ٹی پی سی
1 0 1
کل وقت 12 گھنٹے

مطالعہ پاکستان

حصہ دوم

موضوعات:

- () قیام پاکستان
- () باؤنڈری کمیشن
- () ریڈ کلف ایوارڈ
- () تقسیم بنگال
- () تقسیم پنجاب
- () مسئلہ مہاجرین
- () ریاست کا الحاق
- () ریاست جموں کشمیر
- () نہری پانی کا تنازعہ
- () قرارداد پاکستان
- () علماء کے بائیس نکات
- () 1956-1962 اور 1973 کے دساتیر کی اسلامی / انسانی حقوق کی دفعات (8 تا 28)۔
- () اقلیتوں کے حقوق۔ دیگر محروم طبقات کے حقوق
- () پاکستان کا محل وقوع اور اسکی جغرافیائی اہمیت۔ GSP+ کا تعارف اور عملی طریقہ کار
- () قدرتی وسائل (تیل، گیس، کوئلہ)

غیر مسلم طلباء کے لیے
نصاب اخلاقیات (سال سوئم)

تدریس مقاصد:

عمومی مقاصد:

() ملکی ترقی کے لیے اعلیٰ اوصاف کے ساتھ بہتر طور پر ملک و ملت کی خدمت کر سکے

خصوصی مقاصد: طالب علم اس قابل ہو سکے کہ

() موضوعات کا مطلب بیان کر سکے

() عملی زندگی سے مثالوں کی نشاندہی کر سکے

() موضوعات کی اہمیت بیان کر سکے

() اپنی شخصیت اور معاشرے پر موضوعات کے مطابق اثرات پیدا کرنے کے طریقے بیان کر سکے

() مثبت ذہن کے ساتھ کام کر سکے

() عدل و انصاف سے ادارہ میں، دفتر میں بہتر ماحول پیدا کر سکے

() ماحول کو اخلاقی طور پر پاکیزہ بنائے

() کارکنوں کی بہتر طور پر دل جوئی کر سکے

() کارکردگی میں اضافہ کر سکے

() باہمی احترام کی برکات سے استفادہ کر سکے

() بچوں کے حقوق بیان کر سکے

() عورتوں کے حقوق کی پاسداری کر سکے

() بزرگ شہریوں کے حقوق کا خیال رکھ سکے

() محنت حضرات کے حقوق جان سکے اور ان کے حقوق کی پاسداری کر کے انہیں معاشرے کا ایک مفید فرد بنایا جا سکے

MGM-321: BUSINESS COMMUNICATION

Total contact hours:

Theory	32	T	P	C
Practical	0	1	0	1

Pre-requisite: The students shall already be familiar with the language concerned.

AIMS:

The course has been designed to enable the students to.

1. Develop communication skills.
2. Understand basic principles of good and effective business writing in commercial and industrial fields.
3. Develop knowledge and skill to write technical report with confidence and accuracy.

COURSE CONTENTS

- | | |
|---|----------------|
| 1. COMMUNICATION PROCESS | 6 Hours |
| 1.1 Purposes of communication. | |
| 1.2 Communication process. | |
| 1.3 Distortions in communication. | |
| 1.4 Consolidation of communiqué. | |
| 1.5 Communication flow. | |
| 1.6 Communication of self-development. | |
| 2. COMMUNICATION SKILLS | 6 Hours |
| 2.1 Significance of speaking. | |
| 2.2 Verbal and non-verbal messages. | |
| 2.3 Strategic steps of speaking. | |
| 2.4 Characteristics of effective oral messages. | |
| 2.5 Communication trafficking. | |
| 2.6 Oral presentation. | |
| 3. QUESTIONING SKILLS | 3 Hours |
| 3.1 Nature of question. | |
| 3.2 Types of questions. | |
| 3.3 Characteristics of a good question. | |
| 3.4 Questioning strategy. | |
| 4. LISTENING SKILLS | 5 Hours |
| 4.1 Principles of active listening. | |
| 4.2 Skills of active listening. | |
| 4.3 Barriers to listening. | |
| 4.4 Reasons of poor listening. | |
| 4.5 Giving feedback. | |
| 5. INTERVIEWING SKILLS | 3 Hours |
| 5.1 Significance of interviews. | |
| 5.2 Characteristics of interviews. | |
-

- 5.3 Activities in an interviewing situation.
- 5.4 Types of interviews.
- 5.5 Interviewing strategy.

- 6. **REPORT WRITING** 3 Hours
 - 6.1 Goals of report writing.
 - 6.2 Report format.
 - 6.3 Types of reports.
 - 6.4 Report writing strategy.

- 7. **READING COMPREHENSION** 2 Hours
 - 7.6 Reading problems.
 - 7.7 Four reading skills.

- 8. **GROUP COMMUNICATION** 4 Hours
 - 8.1 Purposes of conducting meetings.
 - 8.2 Planning a meeting.
 - 8.3 Types of meetings.
 - 8.4 Selection of a group for meeting.
 - 8.5 Group leadership skills.
 - 8.6 Running a successful meeting.
 - 8.7 Active participation techniques.

BOOKS RECOMMENDED

- 1. Sh. Ata-ur-Rehman, Effective Business Communication and Report Writing.
 - 2. Ulman J. N. Cloud JR. Technical Reporting.
-

MGM-321: BUSINESS COMMUNICATION

INSTRUCTIONAL OBJECTIVES

On completion of this course, the students will be able to;

1. UNDERSTAND THE COMMUNICATION PROCESS

- 1.1 State the benefits of two way of communication.
- 1.2 Describe a model of communication process.
- 1.3 Explain the major communication methods used in organizations.
- 1.4 Identify the barriers to communication and methods to overcome these barriers.
- 1.5 Identify misconceptions about communication.

2. UNDERSTAND THE PROCESS OF ORAL

- 2.1 Identify speaking situations with other people.
- 2.2 Identify the strategic steps of speaking.
- 2.3 Identify the characteristics of effective oral messages.
- 2.4 State the principles of one-way communication.
- 2.5 State the principles of two-way communication.
- 2.6 Identify the elements of oral presentation skills.
- 2.7 Determine the impact of non-verbal communication on oral communication.

3. DETERMINE THE USES OF QUESTIONING SKILLS TO GATHER AND CLARIFY INFORMATION IN THE ORAL COMMUNICATION PROCESS

- 3.1 Identify different types of questions.
- 3.2 Determine the purpose of each type of question and its application.
- 3.3 Identify the hazards to be avoided when asking questions.
- 3.4 Demonstrate questioning skills.

4. DEMONSTRATE THE USE OF ACTIVE LISTENING SKILLS IN THE ORAL COMMUNICATION PROCESS

- 4.1 State the principles of active listening.
- 4.2 Identify skills of active listening.
- 4.3 Identify barriers to active listening.
- 4.4 State the benefits of active listening.
- 4.5 Demonstrate listening skills.
- 4.6 Explain the importance of giving and receiving feedback.

5. DETERMINE THE APPROPRIATE INTERVIEW TYPE FOR THE SPECIFIC WORK-RELATED SITUATION AND CONDUCT A WORK-RELATED INTERVIEW

- 5.1 State the significance of interviews.
 - 5.2 State the characteristics of interviews.
 - 5.3 Explain the activities in an interviewing situation.
 - 5.4 Describe the types of interviews.
 - 5.5 Explain the interviewing strategy.
 - 5.6 Prepare instrument for a structured interview.
-

- 6. PREPARE A REPORT OUTLINE BASED ON SUBJECT MATTER AND AUDIENCE**
 - 6.1 Identify the different types of reports.
 - 6.2 Determine when to use an informal or formal report presentation.
 - 6.3 Identify the stages of planning a report.
 - 6.4 Identify the parts of a report and choose the parts appropriate for each type of report.
 - 6.5 Draft a report outline.
 - 7. DEMONSTRATE READING COMPREHENSION**
 - 7.1 Identify major reading problems.
 - 7.2 Identify basic reading skills.
 - 7.3 State methods of previewing written material.
 - 7.4 Identify methods of concentration when reading.
 - 7.5 Demonstrate reading comprehension.
 - 8. UNDERSTAND THE PRINCIPLES OF GROUP COMMUNICATION**
 - 8.1 State the purposes and characteristics of major types of meetings.
 - 8.2 Explain responsibilities of a meeting/committee.
 - 8.3 Identify problems likely to be faced at meeting and means to overcome these problems.
 - 8.4 Distinguish between content and process at meetings.
 - 8.5 Explain the key characteristics of a good group facilitator.
-

MGM-322: INDUSTRIAL MANAGEMENT AND HUMAN RESOURCE DEVELOPMENT

T	P	C
2	0	2

Total Contact Hours:

Theory :	64
Practical:	00

Pre-Requisites:

1. General understanding of management and economics activities.
2. Ability to go through the study material.
3. Active mind.
4. Motivation.

AIMS:

1. To develop the management skill of the subject.
2. To acquaint the learner with the principles of management and human relations.
3. To develop psychological approach to solve the labour problems in the industrial set-up.

COURSE CONTENTS

- | | |
|--|----------------|
| 1. INDUSTRIAL PSYCHOLOGY | 2 Hours |
| 1.1 Introduction to management. | |
| 1.2 Brief history of industrial psychology. | |
| 1.3 Definition of psychology. | |
| 1.4 Nature and scope of psychology. | |
| 2. LEADERSHIP | 2 Hours |
| 2.1 Definition. | |
| 2.2 Types. | |
| 2.3 Qualities of a good leader. | |
| 3. MOTIVATION | 3 Hours |
| 3.1 Definition. | |
| 3.2 Types. (Financial and non-financial motives) | |
| 3.3 Conflict of motives. | |
| 4. MORALE | 2 Hours |
| 4.1 Importance. | |
| 4.2 Development. | |
| 4.3 Measurement. | |
| 5. HUMAN ENGINEERING | 2 Hours |
| 5.1 Importance of human factor in industry. | |
| 5.2 Man-machine system. | |
| 5.3 Strategy for making allocation decisions. | |
| 6. INDUSTRIAL FATIGUE AND BOREDOM | 3 Hours |
-

6.1	Definition and distinction.	
6.2	Psychological causes.	
6.3	Objectives causes.	
6.4	Preventions.	
7.	INDUSTRIAL ACCIDENTS	3 Hours
7.1	Psychological causes.	
7.2	Objective causes.	
7.3	Preventions.	
8.	INDUSTRIAL PREJUDICE	2 Hours
8.1	Causes.	
8.2	Remedies.	
9.	PUBLIC RELATION	2 Hours
9.1	Importance.	
9.2	Functions.	
10.	GUIDANCE AND COUNSELLING	3 Hours
10.1	Importance.	
10.2	Choice of job.	
10.3	During service.	
11.	JOB EVALUATION	3 Hours
11.1	Importance.	
11.2	Methods.	
11.3	Job satisfaction.	
11.4	Work simplification.	
12.	WORK APPRAISAL	2 Hours
12.1	Importance.	
12.2	Techniques.	
13.	INDUSTRIAL MANAGEMENT	3 Hours
13.1	Introduction.	
13.2	Functions of Management.	
13.3	Subdivision of Management.	
13.4	Objectives of Industrial Management.	
14.	PLANNING	3 Hours
14.1	The concept.	
14.2	Importance of planning.	
14.3	Steps in planning.	
14.4	Principles of planning.	
15.	PLANT LOCATION AND LAYOUT	4 Hours
15.1	Plant location.	
15.2	Selection of plant location.	
15.3	Types of factory building.	

15.4	Plant layout.	
15.5	Factors affecting it.	
15.6	Process and product layout.	
15.7	Plant location and layout of a factory/printing press.	
16.	PERSONNEL SELECTION	2 Hours
16.1	Recruitment of employees	
16.2	Training.	
16.3	Effects of training on production and product cost.	
17.	WAGE PAYMENT PLANS	3 Hours
17.1	Importance.	
17.2	Principles.	
17.3	Important plans.	
17.4	Effects on production cost.	
18.	TYPES OF PRODUCTION	2 Hours
18.1	Job, batch, flow and mass production.	
18.2	Types of production and cost considerations.	
19.	WORKING CONDITIONS	3 Hours
19.1	Importance.	
19.2	Consideration.	
19.3	Effects on efficiency and per unit cost.	
20.	TIME AND MOTION STUDY	3 Hours
20.1	The concept.	
20.2	Importance of work study for management.	
20.3	Sequence of motion study.	
20.4	Steps to time study.	
20.5	Determination of operations time.	
21.	QUALITY CONTROL	2 Hours
21.1	The concept.	
21.2	Advantages of quality control.	
21.3	Methods.	
22.	ROLE OF FOREMAN IN MANAGEMENT	2 Hours
22.1	Foreman's abilities.	
22.2	Duties.	
22.3	Functions.	
23.	FOREMAN'S KNOWLEDGE OF COST ACCOUNTING	3 Hours
23.1	Concept of cost accounting.	
23.2	Elements of cost.	
23.3	Cost accounting methods.	
24.	PRODUCTIVITY	2 Hours
24.1	The concept.	

- 24.2 Importance.
- 24.3 Factors affecting productivity.
- 25. **ISO-9000** 3 Hours
 - 25.1 Concept of ISO-9000
 - 25.2 Quality policy of products
 - 25.3 Pre-requisites for ISO-9000
 - 25.4 Organization chart and standard operation procedures.
 - 25.5 Pre-accreditation audit.
 - 25.6 ISO-9000 certificate accreditation.

BOOKS RECOMMENDED

1. Industrial Psychology, C. S. Meyers, Oxford University Press, London.
 2. Psychology of Industrial Behaviours, Smith Wakley, McGraw Hill Book Co.
 3. Nizamat-e-Sanaat Aur Insani Rawabat, Ghulam Hussain, Ilmi Kitab Khana, Urdu Bazar, Lahore.
 4. The Process of Management, Andrew R. Megill, William M. Newman.
 5. Management of Industrial Enterprises, Richard N. Omen.
 6. Factory and Production Management, K.G. Lockyer.
-

MGM-322: INDUSTRIAL MANAGEMENT AND HUMAN RESOURCE DEVELOPMENT

INSTRUCTIONAL OBJECTIVES

On completion of this course, the students will be able to;

1. UNDERSTAND THE INDUSTRIAL PSYCHOLOGY

- 1.1 Explain introduction to management
- 1.2 Describe brief history of industrial psychology.
- 1.3 Describe in detail definition of industrial psychology.
- 1.4 Describe nature and scope of industrial psychology.

2. UNDERSTAND THE LEADERSHIP

- 2.1 Define leadership.
- 2.2 Describe types of leadership.
- 2.3 Describe qualities of a good leader.

3. UNDERSTAND THE MOTIVATION

- 3.1 Define motivation.
- 3.2 Describe financial and non financial motives.
- 3.3 Explain conflict of motives.

4. UNDERSTAND THE MORALE

- 4.1 Describe importance of morale.
- 4.2 Describe development of morale.
- 4.3 Describe measurement of morale.

5. UNDERSTAND THE HUMAN ENGINEERING

- 5.1 Explain importance of human engineering in the industry.
- 5.2 Explain man-machine system.
- 5.3 Explain strategy for making allocation decisions.

6. UNDERSTAND THE INDUSTRIAL FATIGUE AND BOREDOM

- 6.1 Describe psychological causes of fatigue and boredom.
- 6.2 Describe objective causes of fatigue and boredom.
- 6.3 Describe preventive measures of fatigue and boredom.

7. UNDERSTAND THE INDUSTRIAL ACCIDENTS

- 7.1 Explain psychological causes of industrial accidents.
- 7.2 Explain objective causes of industrial accidents.
- 7.3 Explain preventive measures of industrial accidents.

8. UNDERSTAND THE INDUSTRIAL PREJUDICE

- 8.1 Explain causes of industrial prejudice.
- 8.2 Explain remedies of industrial prejudice.

9. UNDERSTAND THE PUBLIC RELATIONS

- 9.1 Explain importance of public relations.
 - 9.2 Explain functions of public relations.
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- 10. UNDERSTAND THE GUIDANCE AND COUNSELLING**
 - 10.1 Describe importance of guidance and counselling.
 - 10.2 Describe help of guidance and counselling in choosing the job.
 - 10.3 Describe help of guidance and counselling during service.
 - 11. UNDERSTAND THE JOB EVALUATION**
 - 11.1 Explain importance of job evaluation.
 - 11.2 Explain methods of job evaluation.
 - 11.3 Explain job satisfaction.
 - 11.4 Explain work simplification.
 - 12. UNDERSTAND THE WORK APPRAISAL**
 - 12.1 Explain importance of work appraisal.
 - 12.2 Explain work appraisal techniques.
 - 12.3 Industrial Management and HR/HRD.
 - 13. UNDERSTAND THE INDUSTRIAL MANAGEMENT**
 - 13.1 Explain management.
 - 13.2 Describe functions of management.
 - 13.3 Enlist subdivision of management.
 - 13.4 Explain objectives of industrial management.
 - 14. UNDERSTAND THE PLANNING**
 - 14.1 State planning.
 - 14.2 Describe the importance of planning.
 - 14.3 Identify the steps in planning.
 - 14.4 Enlist principles of planning.
 - 15. UNDERSTAND THE PLANT LOCATION/LAYOUT**
 - 15.1 State plant location.
 - 15.2 Explain selection of plant location.
 - 15.3 Describe types of building.
 - 15.4 State plant layout.
 - 15.5 Explain factors affecting layout.
 - 15.6 Describe process and product layout.
 - 15.7 Explain plant location and layout of an ideal printing press.
 - 16. UNDERSTAND TRAINING AND ITS EFFECTS**
 - 16.1 Describe the recruitment procedure of employees in an industrial concern.
 - 16.2 Explain training.
 - 16.3 Identify the kinds of training.
 - 16.4 State the effects of training on production and product cost.
 - 17. KNOW WAGE IN CENTIME SCHEMES**
 - 17.1 Explain importance of wage payment plans.
 - 17.2 Identify the principles of wage payment plan.
 - 17.3 Describe briefly standard time plan, straight piece rate, differential piece rates.
 - 17.4 State the effects on incentive plans on total cost and labour cost.
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- 18. KNOW TYPES OF PRODUCTION ALONGWITH THEIR IMPACTS ON COST**
 - 18.1 Describe types of production.
 - 18.2 State the effects of production types on cost.
 - 19. UNDERSTAND WORKING CONDITION ALONGWITH EFFECTS ON EFFICIENCY**
 - 19.1 Explain importance of working condition.
 - 19.2 Describe consideration, i.e., air-conditioning ventilation, lighting and noise.
 - 19.3 State the effects of good working condition on efficiency and per unit cost.
 - 20. KNOW ABOUT TIME AND MOTION STUDY**
 - 20.1 Explain the concept.
 - 20.2 Describe the importance of work study.
 - 20.3 Explain the sequence of motion study.
 - 20.4 Identify the principles of motion study.
 - 20.5 Describe the steps of time study.
 - 20.6 Explain the determination of operations time.
 - 21. UNDERSTAND THE QUALITY CONTROL**
 - 21.1 Explain quality control.
 - 21.2 Identify the advantages of quality control.
 - 21.3 Describe methods of quality control.
 - 22. UNDERSTAND THE ROLE OF FORMING IN AN INDUSTRIAL UNDERTAKING**
 - 22.1 Explain ability of the foreman.
 - 22.2 Indentify duties of forming.
 - 22.3 Describe functions of foreman as middle management.
 - 23. KNOW FOREMAN'S KNOWLEDGE OF COST ACCOUNTING**
 - 23.1 Explain concept of cost accounting.
 - 23.2 Explain elements of cost.
 - 23.3 Identify the cost accounting.
 - 24. UNDERSTAND PRODUCTIVITY METHODS**
 - 24.1 Explain the concept.
 - 24.2 Describe importance of productivity.
 - 24.3 State the factors affecting productivity.
 - 25. UNDERSTAND ISO-9000**
 - 25.1 Describe the concept of ISO-9000.
 - 25.2 Explain quality policy of products.
 - 25.3 Enlist and state pre-requisites for ISO-9000.
 - 25.4 Identify organization chart and standard operating procedures.
 - 25.5 Illustrate the need of pre accreditation audit.
 - 25.6 Explain the advantage of ISO-9000 certificate accreditation.
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ELR – 301 BASIC ELECTRONICS APPLIED TO HVAC&R SYSTEMS

Total contact hours:	T	P	C
Practical 96 hours	0	3	1

LEARNING OUTCOMES:

At the end of the course, the students will be able to:-

Understand the basic principles of electronics/electronic controls (components)

LIST OF PRACTICALS

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

1. Identify and verify resistor values using the standard resistor color code.
 2. Identify, test, and evaluate different types of capacitors and their breakdown characteristics.
 3. Construct and verify the operation of the following rectifier circuits:
 - (a) Half-wave rectifier
 - (b) Full-wave rectifier with center-tapped transformer
 - (c) Bridge rectifier
 4. Construct and test different types of filter circuits.
 5. Operate an oscilloscope and analog/digital AVO (multimeter) to measure electrical parameters.
 6. Connect and bias PNP and NPN transistors, and verify their operation.
 7. Construct and test a Zener diode voltage regulator circuit.
 8. Construct and test a chopper circuit.
 9. Inspect and compare switched-mode power supplies (SMPS) and linear power supplies.
 10. Connect and test photovoltaic (PV) cells in series and parallel configurations.
 11. Inspect, analyze, and troubleshoot inverter circuits.
 12. Inspect, analyze, and troubleshoot converter circuits.
 13. Inspect and evaluate the operation of Power Factor Correction (PFC) systems.
 14. Inspect and evaluate Intelligent Power Module (IPM) systems.
 15. Inspect, analyze, and test Insulated Gate Bipolar Transistor (IGBT) circuits.
 16. Identify the pin configuration of a 16-pin linear integrated circuit (IC) and verify its operation.
 17. Complete an electronics project and prepare an industrial visit report.
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HVAC-325: AIR CONDITIONING SYSTEM DESIGN & SUSTAINABILITY

T	P	C
3	6	5

Total contact hours:

Theory:	96 hours
Practical:	192 hours

LEARNING OUTCOMES:

At the end of the course, the students will be able to:

1. Design HVAC&R systems for diverse building types, including load estimation, duct and pipe sizing, and air-handling equipment selection.
2. Understand air-conditioning processes for libraries, clean spaces, computer rooms, data centers, process industries, healthcare facilities, laboratories, pharmaceutical, food technology, and more.

COURSE CONTENTS

PART-A

1. **SCOPE AND USE OF AIR CONDITIONING SYSTEMS** 04 Hours
 - 1.1 Scope of Air-conditioning
 - 1.2 Indoor Air Quality (IAQ) / Indoor Environmental Quality (IEQ)
 - 1.3 Components of Air conditioning system.
 - 1.4 All water (Hydronic) Air conditioning systems.
 - 1.5 All air type air conditioning system.
 - 1.6 Planning, installing, start-up, commissioning and operating the HVAC&R system.
 2. **SELECTION OF DESIGN CONDITIONS** 04 Hours
 - 2.1 Winter Inside & Outside Design Conditions
 - 2.2 Summer Inside & Outside Design Conditions
 3. **HEAT STORAGE, DIVERSITY AND STRATIFICATION** 04 Hours
 - 3.1 Building Orientation
 - 3.2 Storage of heat in building structure; thermal mass / thermal storage
 - 3.3 Diversity of cooling load.
 - 3.4 Stratification of heat.
 - 3.5 Building transmission losses.
 4. **COOLING & HEATING LOAD CALCULATION FOR BUILDINGS** 18 Hours
 - 4.1 External Heat Gain/Loss
 - 4.1.1 Direct radiation
 - 4.1.2 Solar radiation through glass
 - 4.1.3 Shading device
 - 4.1.4 Structural shading
 - 4.1.5 Solar transmission through wall and roofs
 - 4.1.6 Heat gain/loss through exposed walls
 - 4.1.7 Heat gain/loss through exposed windows/Skylight
 - 4.1.8 Heat gain/loss through exposed roof
 - 4.1.9 Heat gain/loss through exposed door
 - 4.1.10 Heat gain/loss through partitions
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4.2	Internal heat gain.	
4.2.1	Occupancy Load	
4.2.2	Lighting Load	
4.2.3	Equipment Load	
4.2.5	Duct Heat Gain & Leakage	
4.2.6	Fan & Pump Heat	
4.3	Problem solving	
5.	VENTILATION & INFILTRATION LOAD	6 Hours
5.1	Infiltration & Exfiltration Concepts	
5.2	Infiltration & Exfiltration calculation	
5.3	Ventilation Load and code compliance	
5.4	Summary of commercial cooling & heating load calculations	
5.5	Problem Solving	
6.	PIPING SYSTEM & SIZING.	17 Hours
6.1	Piping arrangement.	
6.2	Series loop	
6.3	One pipe main	
6.4	Two pipe direct return.	
6.5	Two-pipe reverse return.	
6.6	Combination arrangement.	
6.7	Three pipe system	
6.8	Four pipe system	
6.9	Hydronic pipe sizing	
6.9.1	Frictional Loss from Water Flow in Pipes	
6.9.2	Frictional Loss in Open / Close Systems	
6.9.3	Pressure Loss in Pipe Fittings	
6.9.4	Pressure Drop in Piping System	
6.9.5	System Pipe Sizing	
6.10	Refrigerant pipe sizing	
6.11	Condensate drain pipe sizing	
6.12	Problem Solving	
	<u>PART-B</u>	
7.	TERMINAL UNIT.	7 Hours
7.1	Types of terminal units.	
7.2	Radiators.	
7.3	Convectors.	
7.4	Base board	
7.5	Radiant panel	
7.6	Propeller fan type unit heaters.	
7.7	Cabinet unit heaters.	
7.8	Chilled Beams	
7.9	Fan coil units.	
7.10	Induction unit (Heating & Cooling)	
7.11	Method of selecting terminal unit.	
8.	METHODS OF DUCT DESIGNING.	8 Hours
8.1	Equal friction method.	
8.2	Velocity reduction method.	

8.3	Static regain method.	
8.4	Constant Velocity method.	
8.5	Noise attenuation in ducts.	
8.6	Problem solving.	
9.	SOLAR HEATING AND COOLING SYSTEM	4 Hours
9.1	Solar collectors.	
9.2	Storage and distribution system.	
9.3	Types of solar heating system	
9.4	Solar cooling system	
9.5	Sunshine hours.	
9.6	Collector performance.	
10.	AIR CONDITIONING SYSTEM.	7 Hours
10.1	System classification and their basic controls.	
10.2	All air system.	
10.3	Single zone system	
10.4	Reheat system.	
10.5	Multi-zone system.	
10.6	Dual duct system.	
10.7	Variable air volume system.	
10.8	Airflow requirement (measured in CFM or m ³ /min)	
11.	AIR CONDITIONING SYSTEM OF COMMERCIAL BUILDINGS	12 Hours
11.1	Laboratories (Chemical & Biological)	
11.2	Computer Room/Data Centers.	
11.3	Studios	
11.4	Printing Press	
11.5	Clean Room/Spaces	
11.6	Residences	
11.7	Educational Facility	
11.8	Libraries & Museums	
11.9	Textile and other Industries.	
11.10	Healthcare Facilities (Hospitals etc.)	
11.11	Pharmaceutical Labs	
11.12	Food Technology	
11.13	Process Industry	
11.14	Hotels & Restaurants	
12.	QUANTITY TAKEOFF & COST ESTIMATION	03 Hours
12.1	Project Specifications (Basis & Inputs)	
12.2	Quantity Takeoff (Bill of Quantity (BOQ) / Bill of Material (BOM)	
12.3	Direct Costs: Schedule of Rates/Prices	
12.4	Indirect Costs, Overheads & Profit	
12.5	Risk, Contingency & Escalation	
12.6	Project Completion Time	
13.	GREEN BUILDINGS CONCEPT	02 Hours
13.1	Overview and principles	
13.2	Building Rating Systems (e.g., LEED)	

- 13.3 Accreditation Agencies (e.g., USGBC)
- 13.4 Energy-efficient Design of Buildings & Zero Energy Buildings

RECOMMENDED BOOKS AND SOFTWARES

1. Air conditioning Principle and System by E.G.Pita.
 2. System Design Manual by Carrier
 3. ASHRAE Handbook– Fundamental (Latest Edition)
 4. Manufacture Equipment catalogues by Trane or Carrier Company
 5. ASHRAE Green Buildings resources
 6. Handbook of Air Conditioning system Design by Carrier Air Conditioning Company
 7. Mechanical Estimating Manual by Albert S. Thompson & Leonard P. Laufman
 8. Estimating in Building Construction by Steven J. Peterson & Frank R. Dagostino
 9. Recommended Software:
 - Hourly Analysis Program (HAP)
 - Revit (MEP)
 - ASHRAE Duct Fitting Database
 - McQuay Duct Sizer
 - McQuay Pipe Sizer
 - Green Building Studio
 - Energy Plus
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HVAC-325: AIR-CONDITIONING SYSTEM DESIGN & SUSTAINABILITY

INSTRUCTIONAL OBJECTIVES

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

1. UNDERSTAND THE SCOPE AND USE OF AIR-CONDITIONING SYSTEM

- 1.1 State the scope of air-conditioning in modern age.
- 1.2 Describe Indoor Air Quality (IAQ) / Indoor Environmental Quality (IEQ)
- 1.3 Describe components of Air Conditioning System
 - 1.3.1 Source
 - 1.3.2 Air-distribution system.
 - 1.3.3 Equipment for moving the air or water.
- 1.4 Explain all water (hydronic) air-conditioning system.
- 1.5 Explain all air type air-conditioning system.
- 1.6 Explain planning, installing, startup, commissioning and operating the HVAC&R system.

2. UNDERSTAND THE PROCEDURE OF SELECTING THE OUTSIDE DESIGN CONDITIONS IN WINTER AND SUMMER.

- 2.1 Describe Winter Inside & Outside Design Conditions
- 2.2 Describe Summer Inside & Outside Design Conditions

3. UNDERSTAND THE HEAT STORAGE EFFECT, DIVERSITY AND STRATIFICATION.

- 3.1 Describe building orientation
- 3.2 Describe the storage of heat in building structure.
- 3.3 State the diversity of cooling load.
- 3.4 Define stratification.
- 3.5 State building transmission losses.
- 3.6 Explain thermal storage in a building structure.

4. UNDERSTAND THE PRINCIPLES OF REFRIGERATION AND AIR CONDITIONING LOAD ANALYSIS

- 4.1 Explain direct radiation
 - 4.2 Explain solar radiation through glass
 - 4.3 Explain shading device
 - 4.4 Explain structural shading
 - 4.5 Explain solar transmission through wall and roofs
 - 4.6 Calculate heat gain/loss through exposed walls
 - 4.7 Calculate heat gain/loss through exposed windows/Skylight
 - 4.8 Calculate heat gain/loss through exposed roof
 - 4.9 Calculate heat gain/loss through exposed door
 - 4.10 Calculate heat gain/loss through partitions
 - 4.11 Calculate the heat gain from occupancy Load
 - 4.12 Calculate the heat gain from Lighting Load
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- 4.13 Calculate the heat gain from Equipment Load
 - 4.14 Describe Duct Heat gain/loss & Leakage
 - 4.15 Describe Fan and Pump Heat gain
 - 4.16 Problem Solving
- 5 UNDERSTAND TO CALCULATE THE VENTILATION AND INFILTRATION LOAD OF DIFFERENT TYPES OF BUILDINGS.**
- 5.1 Define infiltration & exfiltration
 - 5.2 Calculate heat gain through ventilation
 - 5.3 Calculate heat gain/loss through infiltration and exfiltration.
 - 5.4 Explain method(s) of commercial cooling & heating load calculations
 - 5.5 Calculate commercial cooling loads
- 6. UNDERSTAND THE PIPING SYSTEM & SIZING.**
- 6.1 Define the term hydronic system.
 - 6.2 Enlist the method of piping arrangement.
 - 6.3 State series loop system.
 - 6.4 State one pipe system.
 - 6.5 State two pipe direct return.
 - 6.6 State two pipe reverse return.
 - 6.7 Explain combination arrangement with the help of drawing.
 - 6.8 Explain three and four pipe system.
 - 6.9 Explain hydronic pipe sizing
 - 6.9.1 Describe Frictional Loss from Water Flow in Pipes
 - 6.9.2 Describe Frictional Loss in Open / Close Systems
 - 6.9.3 Describe Pressure Loss in Pipe Fittings
 - 6.9.4 Describe Pressure Drop in Piping System
 - 6.9.5 Calculate System Pipe Sizing
 - 6.10 Explain refrigerant pipe sizing procedure.
 - 6.11 Explain condensate drain pipe sizing procedure.
 - 6.12 Solve problems on pipe sizing.
- 7. UNDERSTAND THE FUNCTION OF TERMINAL UNITS.**
- 7.1 State the function of air-handling units.
 - 7.2 Enlist the types of terminal units.
 - 7.3 Explain the function of radiators.
 - 7.4 Explain the function of convectors.
 - 7.5 Explain the function of base board.
 - 7.6 Explain the function of radiant panel.
 - 7.7 Explain the function of propeller type unit heaters.
 - 7.8 Explain the function of cabinet unit heater.
 - 7.9 Explain the function of Chilled Beams
 - 7.10 Explain the function of fan coil units.
 - 7.11 Explain the function of induction unit.
 - 7.12 Explain the method of selecting terminal unit.
- 8. METHODS OF DUCT DESIGNING.**
- 8.1 Explain Equal friction method.
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- 8.2 Explain Velocity reduction method.
 - 8.3 Explain Static regain method.
 - 8.4 Explain constant velocity method.
 - 8.5 Explain Noise attenuation in ducts.
 - 8.6 Perform Calculations on duct sizing.
 - 9. UNDERSTAND THE SOLAR HEATING AND COOLING SYSTEMS.**
 - 9.1 Define solar heating and cooling system.
 - 9.2 Describe solar collectors.
 - 9.3 State storage and distribution system.
 - 9.4 Enlist the types of solar heating system.
 - 9.5 Explain solar cooling system.
 - 9.6 State solar radiation energy.
 - 9.7 Calculate the collector performance.
 - 9.8 Explain sunshine hours.
 - 9.9 Describe the method of sizing of collectors.
 - 10. UNDERSTAND THE AIR-CONDITIONING SYSTEMS.**
 - 10.1 Enlist the different types of air-conditioning system.
 - 10.2 Define basic controls used in A/C Systems.
 - 10.3 Describe all air system.
 - 10.4 Describe single zone system.
 - 10.5 Explain reheat system.
 - 10.6 Explain single zone system.
 - 10.7 Explain multi-zone and dual duct system.
 - 10.8 Explain variable air volume (VAV) system.
 - 10.9 Explain all water and air water system.
 - 10.10 Describe unitary versus central system.
 - 10.11 Explain the method used to determine Volumetric Flow rate of air (CFM Calculation).
 - 11. UNDERSTAND AIR CONDITIONING SYSTEMS OF DIFFERENT TYPE OF COMMERCIAL/INDUSTRIAL BUILDINGS**

Explain planning & designing of Air Conditioning System For:

 - 11.1 Laboratories (Chemical & Biological)
 - 11.2 Computer Room/Data Centers
 - 11.3 Studios
 - 11.4 Printing Press
 - 11.5 Clean Room/Spaces
 - 11.6 Residences
 - 11.7 Educational Facility
 - 11.8 Libraries & Museums
 - 11.9 Textile and other Industries.
 - 11.10 Healthcare Facilities (Hospitals etc.)
 - 11.11 Pharmaceutical Labs
 - 11.12 Food Technology
 - 11.13 Process Industry
 - 11.14 Hotels & Restaurants
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12. QUANTITY TAKEOFF & COST ESTIMATION

- 12.1 Describe Project Specifications (scope/WBS, drawings/specs, site constraints, assumptions & exclusions, vendor quote log).
- 12.2 Describe Quantity Takeoff (Bill of Quantity (BOQ) / Bill of Material (BOM) [methods (manual vs. model-based), typical HVAC items (duct, pipe, valves, insulation, equipment), takeoff QA checklist].
- 12.3 Describe Direct Costs: Schedule of Rates/Prices (Materials, labor & productivity, equipment/consumables, subcontract items; quote comparison & normalization).
- 12.4 Describe Indirect Costs, Overheads & Profit (site establishment, prelims, supervision, tooling, testing & commissioning, head-office OH, and profit).
- 12.5 Describe Risk, Contingency & Escalation (Identify risks, percentage contingency, price-escalation clauses, and currency/tax considerations).
- 12.6 Estimating Project Completion Time.

13. GREEN BUILDINGS CONCEPT

- 13.1 Give Introduction of Green Buildings
 - 13.2 Explain Building Rating Systems and describe different international building rating systems for green buildings
 - 13.3 Describe the role of Accreditation Process and Accreditation Agencies such as US Green Building Council (USGBC) Leeds
 - 13.4 Describe Energy Efficient Design of Buildings and Zero Energy Buildings
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HVAC-325: AIR-CONDITIONING SYSTEM DESIGN & SUSTAINABILITY

LIST OF PRACTICALS

192 Hours

On completion of this course the trainees will be able to;

1. Extract project data from architectural drawings for HVAC system design.
2. Calculate heating and cooling loads using standard HVAC load calculation methods.
3. Calculate the cooling load of a building using HVAC design software.
4. Calculate the heating load of a building using HVAC design software.
5. Compute chilled water and refrigerant pipe sizes using HVAC design software.
6. Compute air duct sizes using HVAC design software.
7. Prepare ductwork and piping layouts for a building with a minimum floor area of 5,000 ft².
8. Evaluate HVAC system performance using energy simulation software.
9. Inspect an air-conditioning plant during an industrial visit and identify its major components.
10. Prepare a technical visit report that documents:
 - Functions of major HVAC components.
 - Types and quantities of refrigerants used.
 - Temperature control devices.
 - Air handling units (AHUs).
 - Fan coil units (FCUs).
 - Terminal units.
 - Other significant HVAC equipment.
11. **TECHNICAL PROJECTS**
Design and select HVAC equipment for the following applications:
 - High-rise commercial buildings.
 - Departmental stores.
 - Computer rooms, testing laboratories, and clean spaces.
 - Industrial facilities, including:
 - Electronic manufacturing plants.
 - Textile mills.
 - Cinema houses.
 - Healthcare facilities.
 - Hotels and cafeterias.
 - Data centers.
 - Chemical and biological laboratories.
 - Pharmaceutical facilities.
 - Process industries.
 - Food processing facilities.
 - Libraries and museums.

NOTE:

- (i) Each student group shall be assigned at least two HVAC design projects.
 - (ii) For each project, students shall prepare and present a comprehensive project report containing the following:
 - a. Prepare a cover page.
 - b. Prepare a title page.
 - c. Define the project statement.
 - d. Prepare building drawings or traced architectural layouts.
 - e. Establish the design criteria.
 - f. Calculate heating and cooling loads using approved HVAC design software.
 - g. Determine ventilation requirements in accordance with applicable standards.
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- h. Develop a preliminary HVAC layout showing:
 - Equipment locations.
 - Duct routing.
 - Pipe routing.
- i. Perform distribution system calculations:
 - Duct sizing.
 - Pipe sizing.
- j. Prepare and interpret psychrometric charts for system operation.
- k. Select HVAC equipment based on engineering calculations, including:
 - Air handling units (AHUs).
 - Cooling and heating coils.
 - Circulating pumps.
 - Registers.
 - Grilles.
 - Diffusers.
 - Boilers.
 - Chillers.
 - Cooling towers.
 - Filters.
 - Pumps.
 - Fans.
 - VAV/CAV terminal units.
 - Humidifiers (where applicable).
 - Control valves.
 - Thermostats.
- l. Develop a schematic HVAC control system.
- m. Prepare detailed working drawings with all required construction details.
- n. Prepare a bill of materials (BOM).

Project will be evaluated on correct application of engineering principles, appropriation of system and equipment selected for the problem, organization and presentation of the report.

HVAC-332: WATER AND AIR DISTRIBUTION

	T	P	C
Total Contact Hours	2	0	2
Theory	64 hours		

Learning outcomes: –

At the end of the course, the students will be able to:

1. Understand cooling towers, Pumps chilled/hot water piping system and water treatment.
2. Understand, the basic theory of fluid flow, static velocity and friction head.
3. Understand the air handling units, fans, ducting, air distribution and purification

1. CONDENSERS, CONDENSER LOAD & COOLING TOWER	10 Hours
1.1 Condenser capacity.	
1.2 Function of condenser.	
1.3 Calculate condenser capacity.	
1.4 Quantity and temperature rise of condenser media (air and water).	
1.5 Air cooled condenser, air quantity and velocity.	
1.6 Water cooled condenser, water quantity and velocity.	
1.7 Rating and selection of air- and water-cooled condensers.	
1.8 Evaporative condensers	
1.9 Cooling Towers.	
1.10 Types of Cooling Towers.	
1.11 Cooling Tower Design.	
1.12 Rating and Selection of cooling towers.	
1.13 Problem Solving	
2. FUNDAMENTALS OF PUMPS	10 Hours
2.1 Purpose of Pumps	
2.2 Types of Pumps	
2.3 Pump Laws	
2.4 Pump Hp and Efficiency	
2.5 Pump Head Calculation for Pump Sizing	
2.6 Selection of Pumps	
2.7 Parallel Pumps & selection method	
2.8 Variable Speed Pumping in HVAC&R	
2.9 Problem Solving	
3. PIPING, VALVES AND STRAINERS	8 Hours
3.1 Piping materials and specification.	
3.2 Fitting and joining methods for steel pipe.	
3.3 Fittings and joining methods for copper tubing	
3.4 Valves & Types of valves and strainers.	
3.5 Selection of valves & strainers	
3.6 Pipe insulation.	
3.7 Pipe installation.	
3.8 Vibration and Expansion control	
3.9 Testing, Adjusting and Balancing (TAB)	
4. FUNDAMENTALS OF WATER TREATMENT.	3 Hours
4.1 Water analysis before water treatment	

4.2	Impurities.	
4.3	Kinds of treatment, screening.	
4.4	Sedimentation.	
4.5	Coagulation	
4.6	Filtration,	
5.	CHEMICAL TREATMENT OF WATER.	5 Hours
5.1	Aeration and deaeration.	
5.2	Distillation and neutralization.	
5.3	Organic and in organic control.	
5.4	Corrosion and solubility.	
5.5	Cycle of concentration.	
5.6	Water analysis of treated water	
3.7.	Chemical by-pass feeders	
3.8	Water softeners	
3.9	pH controllers	
3.10	Conductivity controllers.	
3.11	De-ionizers	
6.	FUNDAMENTALS OF FANS.	10 Hours
6.1	Purpose of fans	
6.2	Types of fans.	
6.3	Centrifugal fans and axial fans.	
6.4	Fan Laws.	
6.5	Fan Efficiency and Performance (Centrifugal & Axial Fans)	
6.6	Fan velocity and pressure.	
6.7	Fan HP and efficiency.	
6.8	Fan total pressure.	
6.9	Fan static pressure.	
6.10	Selection of fan.	
6.11	Problem solving.	
7.	FUNDAMENTALS OF DUCTS DESIGN.	6 Hours
7.1	Conventional low velocity duct design.	
7.2	Equivalent rectangular ducts and aspect ratio.	
7.3	Dynamic pressure losses.	
7.4	Pressure losses in elbows and branches take off.	
7.5	Diverging and converging duct sections.	
7.6	Changes in duct friction loss with change in air density.	
7.7	Testing, Adjusting and Balancing (TAB)	
8.	AIR DISTRIBUTION DEVICES.	8 Hours
8.1	Room air distribution.	
8.2	Air patterns.	
8.3	Location of air distribution devices.	
8.4	Air inlet and outlet devices, (Grilles, Diffusers, Registers etc.).	
8.5	Applications.	
8.6	Selection of air inlet and outlet devices	
8.7	Accessories and duct connections.	
7.8.	VAV terminals.	
7.9	Sound and sound control.	

9. AIR CLEANING DEVICES (FILTERS)

4 Hours

- 9.1 Methods of dust removal.
- 9.2 Methods of testing filters.
- 9.3 Types of air cleaners.
- 9.4 Selection of air cleaners.
- 9.5 Methods of filtering air

REFERENCE BOOKS

- 1. Air Conditioning Principles and System by E.G,Pita.
 - 2. Principles of Refrigeration by R.J. Dossat.
 - 3. Trane Air Conditioning manual
 - 4. Refrigeration, Air conditioning and Cold Storage by Gunther.
 - 5. Principles of Air Conditioning by William Coad, Ronal H. Howell and Harry Sauer (ASHRAE)
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HVAC-332: WATER AND AIR DISTRIBUTION

INSTRUCTIONAL OBJECTIVES:

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

1. UNDERSTAND THE CONDENSERS, CONDENSER LOAD CALCULATIONS, COOLING TOWERS AND COOLING TOWER SELECTION.

- 1.1 Define condenser.
- 1.2 Explain the function of condenser.
- 1.3 Calculate condenser capacity.
- 1.4 Explain quantity and temperature size of condenser media (air and water).
- 1.5 Explain air cooled condenser, air quantity and velocity.
- 1.6 Explain water cooled condenser, water quantity and velocity.
- 1.7 Explain rating and selection of air- and water-cooled condensers.
- 1.8 Explain evaporative condensers.
- 1.9 Define cooling towers.
- 1.10 Explain types of cooling towers.
- 1.11 Explain cooling tower design.
- 1.12 State rating and selection of cooling towers
- 1.13 Problem Solving.

2. UNDERSTAND THE FUNDAMENTALS OF PUMPS

- 2.1 Describe Purpose of Pumps
- 2.2 Explain Types of Pumps
- 2.3 State Pump Laws
- 2.4 Define Pump Hp and Efficiency
- 2.5 Calculate Pump Head for Pump Sizing
- 2.6 Describe Selection of Pumps
- 2.7 Describe Parallel Pumps & selection method
- 2.8 Describe Variable Speed Pumping in HVAC&R
- 2.9 Problem Solving

3. UNDERSTAND THE PIPING, FITTINGS, VALVES AND STRAINERS

- 3.1 State the different types of piping materials and their specifications.
- 3.2 Enlist the different types of pipe fittings.
- 3.3 State the method of joining steel pipe and fittings.
- 3.4 State the method of joining copper pipe and fittings.
- 3.5 State the different types of valves and strainers
- 3.6 Explain all types of valves according to its working principle.
- 3.7 Explain the procedure of selecting the valves and strainers.
- 3.8 Explain pipe insulation and different types of pipe insulations.
- 3.9 Explain Pipe installation.
- 3.10 Describe vibration and Expansion control of piping system.
- 3.11 Explain TAB (Water side)

4. UNDERSTAND THE FUNDAMENTALS OF WATER TREATMENT.

- 4.1 State the use and importance of water treatment in air conditioning system.
 - 4.2 Analyze water analysis before water treatment
 - 4.3 Explain impurities of water and types of water treatment.
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- 2.3 Define sedimentation.
 - 2.4 Define coagulation.
 - 2.5 Explain filtration process.
 - 5. UNDERSTAND THE CHEMICAL TREATMENT OF WATER.**
 - 5.1 Define aeration and deaeration.
 - 5.2 Distinguish between distillation and neutralization.
 - 5.3 Explain organic and inorganic control.
 - 5.4 Define corrosion and solubility.
 - 5.5 Explain cycle of concentration.
 - 5.6 Explain water analysis of treated water
 - 3.7. Explain chemical by-pass feeders
 - 3.8 Explain water softeners
 - 3.9 Explain pH controllers
 - 3.10 Explain conductivity controllers.
 - 3.11 Explain de-ionizers
 - 6. UNDERSTAND THE FUNDAMENTALS OF FANS**
 - 6.1 Define the purpose of fans
 - 6.2 Enlist the types of fans.
 - 6.3 Define centrifugal fans and axial fans.
 - 6.4 Describe fan laws.
 - 6.5 State fan efficiency for Centrifugal & Axial Fans.
 - 6.6 Define fan velocity and pressure.
 - 6.7 Define fan HP and efficiency.
 - 6.8 State fan total pressure.
 - 6.9 State fan static pressure.
 - 6.10 State selection of fan.
 - 6.11 Solve problems.
 - 7. UNDERSTAND THE FUNDAMENTALS OF DUCT DESIGN.**
 - 7.1 Explain conventional low velocity duct design.
 - 7.2 Describe equivalent rectangular ducts and aspect ratio.
 - 7.3 Calculate dynamic pressure losses in duct elbows and branch take off.
 - 7.4 Calculate the pressure losses in duct elbows and branch take off.
 - 7.5 State diverging and converging duct section.
 - 7.6 Explain the changes in duct friction loss with change in air density.
 - 7.7 Explain TAB (Air Side)
 - 8. UNDERSTAND THE AIR DISTRIBUTION DEVICES.**
 - 8.1 Explain room air distribution.
 - 8.2 Define air patterns.
 - 8.3 Describe location of air distribution devices.
 - 8.4 Explain air inlet and outlet devices, (Grilles, Diffusers, Registers etc.).
 - 8.5 Describe applications of air devices.
 - 8.6 Explain the method of selection of air inlet and outlet devices
 - 8.7 Explain accessories and duct connection.
 - 8.8 State VAV terminals.
 - 8.9 Explain sound and sound control.
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9. UNDERSTAND THE AIR CLEANING DEVICES.

- 9.1 Define the different methods of dust removal.
 - 9.2 Define the method of testing filters.
 - 9.3 State the types of air filter.
 - 9.4 State the types of air cleaner.
 - 9.5 Explain the selection of air cleaners.
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HVAC-344: CONTROLS AND INSTRUMENTATION

T	P	C
3	3	4

Total contact hours:

Theory	96 hours
Practical	96 hours

AIM: At the end of the course, the students will be able to:-

- (i) Understand the basic principles of electronics
- (ii) Understand the principles of selection, installation and operation of various types of Electrical, Electronic, Pneumatic, Electro-mechanical and Electro-pneumatic controls
- (iii) Understand the operation of control elements, such as sensors, controllers, actuators and related accessories
- (iv) Understand the role of instruments commonly used in HVAC&R control systems.

Part-A

1. INTRODUCTION OF CONTROLS & INSTRUMENTATION 12 Hours

- 1.1. Importance of control system in HVACR
 - 1.2. Definition of terminology used in control system
 - 1.2.1. Control system
 - 1.2.2. Control device
 - 1.2.3. Control agent
 - 1.2.4. Controlled variable
 - 1.2.5. Digital & Analog Input and Outputs
 - 1.2.6. Control media
 - 1.2.7. Desired value
 - 1.2.8. Set point
 - 1.2.9. Differential
 - 1.2.10. Proportional band
 - 1.2.11. Cycling
 - 1.2.12. Open loop control system
 - 1.2.13. Closed loop control system
 - 1.2.14. Block / Schematic Diagram
 - 1.2.15. Logic Controls (AND, OR, NOT etc.)
 - 1.2.16. Direct Digital Controls (DDC)
 - 1.3. Basic Functions of parts
 - 1.3.1. Controllers
 - 1.3.2. Sensors
 - 1.3.3. Actuators
 - 1.3.4. Accessories
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2.	CONTROL SYSTEMS	5 Hours
2.1.	Two position	
2.2.	Timed two position	
2.3.	Multi-position control	
2.4.	Proportional control	
2.5.	Floating control	
2.6.	Self-contained controls	
2.7.	Individual control	
2.8.	Single zone control	
2.9.	Multi-zone control	
3.	TEMPERATURE CONTROL & SENSORS	3 Hours
3.1.	Resistance Temperature Detectors (RTDs)	
3.2.	Thermocouple	
3.3.	Thermistor	
3.4.	Bi-metal	
4.	HUMIDITY SENSORS	3 Hours
4.1.	Hygroscopic Humidistat	
4.2.	Electrical Humidistat	
4.2.1	Capacitive	
4.2.2	Resistive	
4.3.	Electronic Humidistat	
4.4.	Photoelectric sensor type Humidistat	
5.	PRESSURE SENSORS	2 Hours
5.1.	Bellows	
5.2.	Diaphragm	
5.3.	Bourdon tube	
5.4	Transducers as pressure sensors	
6.	LIQUID LEVEL AND CONSTANT FLOW CONTROL	2 Hour
6.1.	Float Switches	
6.2.	Ultrasonic and Capacitive Level Sensor	
6.3.	Flow Meters	
7.	FLOW CONTROL DEVICES	12 Hours
7.1.	Automatic control valves terminology	
7.2.	Types of automatic control valves	
7.2.1.	Single-seated valve	
7.2.2.	Pilot piston valve	
7.2.3.	Double-seated valve	
7.2.4.	3-way mixing valve	
7.2.5.	3-way diverting valve	
7.3.	Valve Actuators	
7.3.1	Solenoid	
7.3.2.	Electric motor	
7.3.3.	Pneumatic diaphragm	
7.4.	Damper	
7.4.1.	Single leaf	

	7.4.2. Multi-leaf	
	7.4.3. Butterfly	
	7.4.4. Opposed blade	
	7.4.5. Damper actuators/motors	
	7.4.5.1 Solenoid / Hydraulic	
	7.4.5.2 Motorized	
	7.4.5.3 Pneumatic Diaphragm	
8.	ELECTRICAL CONTROLS	6 Hours
	8.1. Electrical controls and its advantages	
	8.2. Electrical control elements, Bridge circuit theory	
	8.3. Over loads	
	8.4. Timers	
	8.5. Relays (Electromechanical, Solid State etc.)	
	8.6. Contactors	
	PART -B	
9.	REVIEW OF FUNDAMENTALS OF ELECTRONICS CONTROLS APPLIED TO HVAC&R SYSTEMS	10 Hours
	9.1 Terms used in electronics	
	9.2 Electronic controls and its advantages	
	9.3 Electronic control components:	
	9.3.1. Diodes	
	9.3.2. Transducers	
	9.3.3. Transistors	
	9.3.4. Rectifiers	
	9.3.5. Amplifiers	
	9.3.6. Potentiometer	
	9.3.7. Thermistor	
	9.4 pH and Conductivity controller	
	9.5 Microcontroller (Arduino, ESP32 etc.)	
	9.6 Variable Frequency Drive (VFD)	
10.	PNEUMATIC AND HYDRAULIC CONTROLS	7 Hours
	10.1. Pneumatic controls and its advantages	
	10.2. Hydraulic controls and its advantages	
	10.3. Compressed air- source of power	
	10.3.1. Air-compressor (oil free type) and storage tanks	
	10.3.2. Compressed air filters	
	10.3.3. Refrigerated driers	
	10.3.4. Compressed air lines and accessories	
11.	SMART HVAC AND IOT INTEGRATION	3 Hours
	11.1. Introduction to IOT	
	11.2. Applications of IOT in HVACR	
	11.3. Smart thermostats (e.g., Nest, Honeywell etc.)	
	11.3 Remote monitoring and cloud-based controls	
12.	ELECTRICAL CONTROL CIRCUITS	9 Hours
	13.1 Two-wire control circuits	

- 13.1.1. Line voltage
 - 13.1.2. Low voltage
 - 13.2. Three-wire two position control circuits
 - 13.2.1. Double-throw three-wire circuit
 - 13.2.2. Complete three wire control circuit
 - 13.3 Multi-position control Circuits.
 - 13.3.1. Full off circuit
 - 13.3.2. Part on circuit
 - 13.3.3. Full on circuit
 - 13.4 Floating control circuits
 - 13.4.1. Typical floating control circuit
 - 13.5 Proportional control circuits
 - 13.5.1 Proportional controllers
 - 13.5.2. Proportional motor
 - 13.5.3. Balancing relay
 - 13.5.4. Motor balancing potentiometer
 - 13. CENTRAL COMPUTER CONTROLLED BUILDING HVAC&R MANAGEMENT SYSTEM** 10 Hours
 - 13.1. Introduction of Building Management System (BMS) for Monitoring, Switching & Control and Integrated Building Management System (IBMS)
 - 13.2. Microprocessor based direct digital controls (DDC) and communication protocols (BACnet, Modbus, KNX etc.)
 - 13.3. Study the microprocessor controller and its programming
 - 13.4. System Integration
 - 13.5. Data Logging / Trend Logging of building management system
 - 14.6 Energy Optimization through BMS / IBMS (Niagara, Siemens Desigo etc.)
 - 14.7 Advanced Control Strategies
 - 14. PREVENTIVE MAINTENANCE (PM) & SCHEDULING** 6 Hours
 - 15.1 Preventive Maintenance (PM) and calibration of various control system
 - 15.2 Preparation of sentence schedules:
 - 15.2.1. Daily maintenance schedule
 - 15.2.2. Weekly maintenance schedule
 - 15.2.3. Monthly maintenance schedule
 - 15.2.4. Yearly maintenance schedule
 - 15. INSTRUMENTS** 6 Hours
 - 15.1. Thermometers
 - 15.1.1. Pipe line thermometers
 - 15.1.2. Duct thermometers
 - 15.2. Flow recorders
 - 15.3. Pressure recorders
 - 15.4. Temperature recorders
 - 15.5. Temperature and flow recorders
 - 15.6. Velocity meters
 - 15.7. Manometers
 - 15.8. pH meters
 - 15.9. Conductivity meters
 - 15.10. Flue gas analyzer
 - 15.11. Electronic leak detectors
 - 15.12. Ultrasonic Flow Meters
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RECOMMENDED BOOKS AND SOFTWARE

1. Automatic Controls of Heating and Air-conditioning by John E. Hains
 2. ASHRAE Hand Book- Application & Equipment Volume (Latest Edition).
 3. Book on Controls by Honeywell
 4. Manual prepared by National Institute of Science & Technology (NISTE), Ministry of Education, Government of Pakistan, Islamabad
 5. Softwares:
 - Niagara
 - Siemens Desigo
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HVAC-344: CONTROLS AND INSTRUMENTATION

INSTRUCTIONAL OBJECTIVES

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

1. UNDERSTAND THE ROLE OF CONTROLS & INSTRUMENTATION, CONTROL TERMINOLOGY AND BASIC FUNCTION OF COMPONENTS USED IN CONTROL SYSTEMS

- 1.1. Describe importance of control system in HVACR
- 1.2. State the terminology used in control system
 - 1.2.1. Define control system
 - 1.2.2. Define Digital & Analog Inputs and Outputs, controlled variable, control medium, desired value.
 - 1.2.3. Describe set point, differential, proportional band, cycling
 - 1.2.4. Explain open loop control system
 - 1.2.5. Explain closed loop control system
 - 1.2.6. Describe block diagram
- 1.3. Explain basic functions of parts
 - 1.3.1. Define controllers, sensors, actuators, accessories
- 1.4. Explain safety controls

2. UNDERSTAND THE FUNCTION AND USE OF CONTROL SYSTEMS

- 2.1. Define two position
- 2.2. Explain multi-position control
- 2.3. Describe proportional control
- 2.4. Define floating control
- 2.5. Explain self-contained controls
- 2.6. Define individual control
- 2.7. Explain single zone control
- 2.8. Describe multi-zone control

3. UNDERSTAND THE FUNCTION AND USE OF TEMPERATURE CONTROLS AND SENSORS

- 3.1. Resistance Temperature Detectors (RTDs)
- 3.2. Define thermocouples
- 3.3. Define thermistor
- 3.4. Define bi-metal

4. UNDERSTAND THE ROLE AND FUNCTION OF HUMIDITY SENSORS

- 4.1. Define hygroscopic humidistat
 - 4.2. Define Electrical Humidistat
 - 4.2.1 Capacitive
 - 4.2.2 Resistive
 - 4.3. Define electronic humidistat
 - 4.4. Explain photoelectric sensor type humidistat
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- 5. UNDERSTAND THE FUNCTION AND USE OF PRESSURE SENSORS**
 - 5.1. Describe bellows
 - 5.2. Define diaphragm
 - 5.3. Define bourdon tube
 - 5.4. Describe Transducers
 - 6. UNDERSTAND THE FUNCTION AND USE OF LIQUID LEVEL AND CONSTANT FLOW CONTROLS**
 - 6.1. Describe float switches
 - 6.2. Describe ultrasonic and capacitive level sensor
 - 6.3. Describe flow meters
 - 7. UNDERSTAND THE WORKING PRINCIPLES AND USE OF FLOW CONTROL DEVICES**
 - 7.1. Define automatic control valves terminology
 - 7.2. Enlist the types of automatic control valves
 - 7.2.1. Define single-seated valve, pilot piston valve, double-seated valve
 - 7.2.2. Explain 3-way mixing valve
 - 7.2.3. Explain 3-way diverting valve
 - 7.3. Explain valve Actuators
 - 7.3.1. Explain solenoid
 - 7.3.2. Describe electric motor
 - 7.3.3. Explain pneumatic diaphragm
 - 7.4. Explain dampers
 - 7.4.1. Define single leaf, multi-leaf, butterfly, and opposed blade
 - 7.4.2. Explain damper actuators/motors Solenoid / Hydraulic, Motorized and Pneumatic Diaphragm
 - 8. UNDERSTAND THE FUNCTION AND THE USE OF ELECTRIC CONTROLS**
 - 8.1. Describe electric controls and its advantages
 - 8.2. Explain electric control elements, Bridge circuit theory
 - 8.3. Explain over loads
 - 8.4. Define timers
 - 8.5. Explain Relays (Electromechanical, Solid State etc.)
 - 8.6. Explain Contactors
 - 9. UNDERSTAND THE FUNDAMENTALS OF ELECTRONICS CONTROLS APPLIED TO HVAC&R SYSTEMS**
 - 9.1. Define terms used in electronics
 - 9.2. Describe electronic controls and its advantages
 - 9.3. Explain electronic control components:
 - 9.3.1. Define diodes, transducers, transistors, rectifiers, amplifiers, potentiometer, and thermistor
 - 9.4. Explain pH controller and conductivity controller
 - 9.5. Explain Microcontroller (Arduino, ESP32 etc.)
 - 9.6. Explain Variable Frequency Drive (VFD)
 - 10. UNDERSTAND THE WORKING PRINCIPLES AND USE OF PNEUMATIC CONTROLS**
 - 10.1. Explain pneumatic controls and its advantages
 - 10.2. Explain hydraulic control and its advantages
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- 10.3. Define compressed air-source of power
 - 10.3.1. Define air-compressor (oil free type) and storage tanks, compressed air filters
 - 10.3.2. State refrigerated driers
 - 10.3.3. Define compressed air lines and accessories
 - 11. UNDERSTAND SMART HVAC AND IOT INTEGRATION**
 - 11.1. Explain concept, architecture and protocols (MQTT, Wi-Fi, ZigBee etc.) used in IOT
 - 11.2. Explain Smart thermostats (e.g., Nest, Honeywell etc.)
 - 11.3. Explain Remote monitoring and cloud-based controls
 - 11.4. Describe applications of IOT in HVACR.
 - 12. UNDERSTAND THE DIFFERENT TYPES OF ELECTRIC CONTROL CIRCUITS**
 - 13.1 Draw two-wire control circuits, line voltage circuits, low voltage circuits
 - 13.2. Draw three-wire two position control circuits, double-throw three-wire circuit, complete three wire control circuit
 - 13.3. Draw multi-position control circuits, full off circuit, part on circuit, full on circuit.
 - 13.4. Draw floating control circuits, typical floating control circuit
 - 13.5. Draw Proportional control circuits
 - 13.5.1. Explain proportional controllers, proportional motor, balancing relay, motor balancing potentiometer
 - 13. UNDERSTAND THE APPLICATIONS OF HVAC&R CENTRALLY COMPUTERIZED CONTROLLED BUILDING MANAGEMENT SYSTEMS**
 - 13.1. Explain building management system (BMS) and Integrated Building Management System (IBMS)
 - 13.2. Explain microprocessor based direct digital control (DDC) and communication protocols (BACnet, Modbus, KNX etc.)
 - 13.3. Describe the microprocessor controller and its programming
 - 13.4. Explain system integration with fire alarms, access control and lighting
 - 13.5. Calculate the data generation of building management system
 - 14.6 Describe Energy Optimization through BMS / IBMS using softwares (Niagara, Siemens Desigo etc.)
 - 14.7 Explain PID control tuning, sequencing and staging.
 - 14.8 Explain energy optimization and demand control
 - 14.9 Explain fault detection and diagnostics
 - 14.10 Explain free cooling
 - 14. UNDERSTAND THE METHODS AND TECHNIQUES OF MAINTENANCE**
 - 15.1 Explain the maintenance and calibration of various control system
 - 15.2 Prepare the maintenance schedules:
 - 15.2.1. Prepare and notify the daily maintenance schedule
 - 15.2.2. Prepare and notify the weekly maintenance schedule
 - 15.2.3. Prepare and notify the monthly maintenance schedule
 - 15.2.4. Prepare and notify the yearly maintenance schedule
 - 15. UNDERSTAND THE APPLICATION AND USE OF INSTRUMENTS**
 - 15.1. Explain Thermometers, Pipe line thermometers, Duct thermometers
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- 15.2. Define Flow recorders, Pressure recorders, Temperature recorders, Temperature and Flow recorders
 - 15.3. Explain Velocity meters
 - 15.4. Explain manometers
 - 15.5. Define pH meters, conductivity meters
 - 15.6. Explain flue gas analyzer, electronic leak detectors and ultrasonic flow meters.
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HVAC-344: CONTROLS AND INSTRUMENTATION

LIST OF PRACTICALS

96 Hours

On completion of the course, the trainees will be able to;

1. Inspect and connect a heating thermostat.
 2. Inspect and connect a combination thermostat.
 3. Inspect and test a solenoid valve.
 4. Identify and demonstrate different temperature sensing elements.
 5. Evaluate the operating accuracy of a thermostat.
 6. Identify relays, contactors, and motor starters.
 7. Inspect and test a packaged sequencer.
 8. Inspect and test a fan limit control.
 9. Measure air velocity in a duct using an anemometer.
 10. Install and use a water manometer to measure pressure.
 11. Measure air velocity in a duct system using a Pitot tube.
 12. Measure air velocity in a duct using a velocity meter.
 13. Measure the pressure drop across an air filter.
 14. Identify the control devices of a central air conditioning system.
 15. Perform a control system checkout on an all-weather HVAC system.
 16. Inspect and test a four-way reversing valve during heating and cooling cycles.
 17. Inspect and test low-voltage field control circuits at individual components.
 18. Calculate the heating and cooling loads for an assigned conditioned space.
 19. Draw a two-wire control circuit diagram.
 20. Draw a three-wire control circuit diagram.
 21. Draw a floating control circuit diagram.
 22. Draw a multi-position control circuit diagram.
 23. Draw a Wheatstone bridge circuit diagram.
 24. Adjust and calibrate differential settings of various thermostats.
 25. Identify and demonstrate the components and operation of a typical pneumatic control system.
 26. Identify and demonstrate the operation of different recording instruments, including temperature, flow, and humidity recorders.
 27. Use water balancing instruments, including pressure gauges, thermometers, and flow indicators, to measure hydronic system parameters.
 28. Analyze multi-story commercial and industrial buildings to determine HVAC zoning requirements.
 29. Inspect HVAC&R control systems during an industrial visit and document the applications and control circuit diagrams used in commercial and industrial buildings.
 30. Demonstrate the applications of the Internet of Things (IoT) in HVAC&R systems.
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HVAC-352: INDUSTRIAL REFRIGERATION AND AIR CONDITIONING MACHINES & EQUIPMENT

	T	P	C
Total contact hours:	2	0	2
Theory	64 hours		

AIM: At the end of the course, the students will be able to:

1. Knowledge the working principles of industrial absorption, centrifugal and steam jet refrigeration system.
2. Understand the working principles of air washers, cooling tower designs and other industrial refrigeration equipment.

- 1. ABSORPTION AIR CONDITIONING SYSTEM.** 10 Hours
 - 1.1 Fundamentals of Vapor Absorption Cycle.
 - 1.2 Construction, major parts and working principle of absorption cold generator
 - 1.3 Types of absorption machine according to construction (Single Shell & Double Shell)
 - 1.4 Types of absorption machine according to effect (Single Generator & Double Generator).
 - 1.5. Types of absorption machine according to firing (Steam-fired, Hot Water Fired and Direct Fired)
 - 1.6 Causes of crystallization and its remedies.
 - 1.7 Cooling water control in absorption machine
 - 1.8 Special applications.
 - 2. JET EJECTOR REFRIGERATION SYSTEM.** 2 Hours
 - 2.1 Introduction of Jet Ejector Refrigeration System.
 - 2.2 Working principle and constructional features of Jet Ejector Refrigeration System.
 - 2.3 Detail of major parts of the machine
 - 2.4 Different types of refrigerants used in Jet Ejector Refrigeration system
 - 3. AIR WASHER SYSTEM.** 6 Hours
 - 3.1 Air washers and its Types
 - 3.2 Air washer computations.
 - 3.3 Modern Hybrid Design of Air Washer.
 - 3.4 Cooling and humidification.
 - 3.5 Heating and humidification.
 - 3.6 Applications of air washers.
 - 3.7 Problem solving
 - 4. CENTRIFUGAL CHILLERS** 9 Hours
 - 4.1 Centrifugal compressor.
 - 4.2 Types, construction of centrifugal compressors and lubrication system.
 - 4.3 Efficiency and performance of centrifugal chillers.
 - 4.4. Capacity control and Sequencing of Centrifugal chillers.
 - 4.5 Application of centrifugal Chillers.
 - 4.6 Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)
 - 4.7 Hybrid Chillers
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5. **SCREW CHILLERS** 7 Hours
- 5.1 Screw compressor.
 - 5.2 Types (Single & Twin), construction of Screw compressors and lubrication system.
 - 5.3 Efficiency and performance of Screw chillers.
 - 5.4 Capacity control of Screw Chillers.
 - 5.5 Application of Screw Chillers.
 - 5.6 Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)
6. **SCROLL CHILLERS** 6 Hours
- 6.1 Scroll compressor.
 - 6.2 Types and construction of Scroll compressors and lubrication system.
 - 6.3 Efficiency and performance of Scroll chillers.
 - 6.4 Capacity control of Scroll Chillers.
 - 6.5 Application of Scroll Chillers.
 - 6.6 Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)
7. **COMMERCIAL AIR CONDITIONING SYSTEM.** 12 Hours
- 7.1 Types of commercial air-conditioning systems
 - 7.1.1 Packaged units.
 - 7.1.2 Roof-top units
 - 7.1.3 Split units (Inverter & Non-Inverter).
 - 7.1.4 Multi-evaporator (mini) split system
 - 7.1.5 Centrally air conditioning system and auxiliary equipment (water chillers, boilers, cooling towers, AHUs, FCUs, VAV Units, circulating pumps, heat exchangers, air separator, oil separators, compression tank expansion tank etc.)
 - 7.1.6 Variable Refrigerant Flow (VRF)
 - 7.1.7 Dedicated Outdoor Air Systems
 - 7.1.8 Energy Recovery Ventilators
 - 7.2 Flow diagram of centrally air-conditioning system.
 - 7.3 Electrical circuit diagram of packaged units.
 - 7.4 Electrical circuit diagram of split units.
8. **HUMIDITY CONTROL AND IAQ.** 6 Hours
- 8.1 Purpose of humidifiers and dehumidifiers (residential & industrial)
 - 8.2 Types of humidifiers.
 - 8.3 Types of dehumidifiers.
 - 8.4 Working principles and construction detail of humidifiers and dehumidifiers.
 - 8.5 IAQ enhancements
9. **ICE PLANTS.** 6 Hours
- 9.1 Commercial ice plant (reciprocating vapor compression system using ammonia as refrigerant).
 - 9.2 Construction detail of refrigeration cycle of ice plant.
 - 9.3 Safety Measure for Ammonia-based System.
 - 9.4 Load calculation of cold storage.
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REFERENCE BOOK

1. ASHRAE Systems & Equipment (Latest Ed.)
 2. Modern Refrigeration and Air-conditioning by Althouse.
 3. Principles of Air conditioning by E.G. Pita
 4. Industrial Refrigeration and Air Conditioning Machines & Equipment (Manual), Ministry of Education, Islamabad.
 5. Trane Air-conditioning manual.
 6. Principles of Refrigeration by R. J. Dossat
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HVAC-352: INDUSTRIAL REFRIGERATION & AIR CONDITIONING MACHINE & EQUIPMENT.

INSTRUCTIONAL OBJECTIVES:

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

- 1. UNDERSTAND THE CONSTRUCTION AND WORKING PRINCIPLES OF AN ABSORPTION REFRIGERATION MACHINE.**
 - 1.1 State the fundamentals of absorption cycle.
 - 1.2 Explain the construction, major parts and working principle of absorption cold generator
 - 1.3 Explain the types of absorption machine according to construction (single shell & double shell)
 - 1.4 Explain the types of absorption machine according to effect (single generator & double generator).
 - 1.5. Explain the types of absorption machine according to firing (steam-fired, hot water fired and direct fired)
 - 1.6 State the causes of crystallization and its remedies.
 - 1.7 Describe cooling water control in absorption machine and its special applications.
 - 2. UNDERSTAND THE STEAM JET REFRIGERATION SYSTEM.**
 - 2.1 Define the introduction of steam jet refrigeration system.
 - 2.2 Explain the working principle and constructional features of steam jet refrigeration system.
 - 2.3 Explain the major parts of the machine and its special applications.
 - 3. UNDERSTAND THE WORKING PRINCIPLE OF AIR WASHER AND ITS APPLICATIONS**
 - 3.1. Define air washer
 - 3.2 Define types of air washers
 - 3.3 Process air washer computations.
 - 3.4 Explain cooling and humidification.
 - 3.5 Explain heating and humidification.
 - 3.6 Describe applications of air washers.
 - 3.7 Solve problems
 - 4. UNDERSTAND THE CONSTRUCTION AND WORKING PRINCIPLES OF CENTRIFUGAL CHILLERS.**
 - 4.1 Define Centrifugal compressor.
 - 4.2 Describe Types and construction of Centrifugal compressors and lubrication system.
 - 4.3 Describe Efficiency and performance of Centrifugal chillers.
 - 5.4. Describe Capacity control of Centrifugal Chillers.
 - 5.5 Describe Application of Centrifugal Chillers.
 - 5.6 Describe Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)
-

- 4.4 Describe Steam Driven Chillers (Steam as prime mover)
 - 4.5 Describe the application of centrifugal chillers.
 - 5. **UNDERSTAND THE CONSTRUCTION AND WORKING PRINCIPLES OF SCREW CHILLERS**
 - 5.1 Define Screw compressor.
 - 5.2 Describe Types and construction of Screw compressors and lubrication system.
 - 5.3 Describe Efficiency and performance of Screw liquid chillers.
 - 5.4. Describe Capacity control of Screw Chillers.
 - 5.7 Describe Application of Screw Chillers.
 - 5.8 Describe Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)
 - 6. **UNDERSTAND THE CONSTRUCTION AND WORKING PRINCIPLES OF SCROLL CHILLERS**
 - 6.1 Define Scroll compressor.
 - 6.2 Describe Types and construction of Scroll compressors and lubrication system.
 - 6.3 Describe Efficiency and performance of Scroll chillers.
 - 6.4 Describe Capacity control of Scroll Chillers.
 - 6.5 Describe Application of Scroll Chillers.
 - 6.6 Describe Variable Frequency Drive (VFD) and Variable Speed Drive (VSD)
 - 7. **UNDERSTAND DIFFERENT TYPES OF COMMERCIAL AIR CONDITIONING SYSTEM.**
 - 7.1 Describe Types of commercial air-conditioning systems
 - 7.1.1 Packaged units.
 - 7.1.2 Roof-top units
 - 7.1.3 Split units.
 - 7.1.4 Multi-evaporator (mini) split system
 - 7.1.5 Centrally air conditioning system and ancillary equipment (water chillers, boilers, cooling towers, AHUs, FCUs, VAV Units, circulating pumps, heat exchangers, air separator, oil separators, compression tank expansion tank etc.)
 - 7.1.6 Variable Refrigerant Flow (VRF)
 - 7.2 Explain Flow diagram of centrally air-conditioning system.
 - 7.3 Explain Electrical circuit diagram of packaged units.
 - 7.4 Explain Electrical circuit diagram of split units.
 - 8. **UNDERSTAND THE DIFFERENT TYPES OF HUMIDIFIERS AND DEHUMIDIFIERS.**
 - 8.1 State the purpose of humidifiers and dehumidifiers (residential & industrial).
 - 8.2 Explain the types of humidifiers (pan, pad and atomizing type)
 - 8.3 Explain the types of dehumidifiers (cooling coil and chemical)
 - 8.4 State the working principles and construction detail of humidifiers and dehumidifiers.
 - 8.5 Explain IAQ enhancements
 - 9. **UNDERSTAND THE ICE PLANTS**
 - 9.1 Describe the commercial ice plant (reciprocating vapor compression system using ammonia as refrigerant).
 - 9.2 Explain construction detail of refrigeration cycle of ice plant.
 - 9.3 Describe Safety Measures for Ammonia-based Systems
 - 9.4 Calculate the cooling load capacity of cold storage.
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HVAC-362: HEAT TRANSFER AND REFRIGERATION CALCULATIONS

T	P	C
2	0	2

Total contact hours:

Theory 64 hours

LEARNING OUTCOMES:

The students will be able to:

1. Understand heat transfer applied to the Refrigeration and Air Conditioning.
2. Design Refrigeration and Air Conditioning components

1. HEAT AND MASS TRANSFER.

8 Hours

- 1.1 Introduction to Heat Transfer.
- 1.2. Methods of heat transfer, conduction, convection and radiation.
- 1.3. Heat transfer by conduction through homogeneous and composite structures.
- 1.4 Absorption, Reflection, Transmission, Black Body, Planck's Law, Kirchhoff's Law, Emissivity and Absorptivity
- 1.5 Mass Transfer
 - 1.5.1 Mass transfer in HVAC
 - 1.5.2 Moisture migration through walls and ducts

2. DETERMINATION OF OVER ALL CO-EFFICIENT OF HEAT TRANSFER

6 Hours

- 2.1 Thermal conductivity of materials. (Solid, Liquid and Gases)
- 2.2 Thermal conductance of material.
- 2.3 Thermal resistance of material.
- 2.4 Determination of "U" factor by calculation and formulas.
- 2.5 "U" factor of insulated pipe.
- 2.6 Flow of heat through walls
- 2.7 Flow of heat through walls with varying outdoor temperatures.
- 2.8 Problem Solving.

3. PROPERTIES OF INSULATORS AND CONDUCTORS.

12 Hours

- 3.1 Insulation and their properties
 - 3.1.1 Thermal
 - 3.1.2 Mechanical
 - 3.2 General building insulation practice
 - 3.2.1 Wood frame construction
 - 3.2.2 Steel frame construction
 - 3.2.3 Masonry frame construction
 - 3.3 Heat Transfer Factors
 - 3.3.1 Fluid factor.
 - 3.3.2 Tube factor
 - 3.3.3 Temperature factor.
 - 3.3.4 Surface factor
 - 3.3.5 Designing factor.
 - 3.4 General industrial insulation practice
 - 3.4.1 Pipes
 - 3.4.2 Ducts
-

3.4.3	Tanks & Vessels	
3.5	Heat surface area calculation for air cooled finned coil condenser	
3.6	Heat surface area calculation for water cooled condenser	
3.7	Heat surface area calculation for evaporator coil	
3.8	Common window glass	
3.9	Shade glass	
3.10	Other types of glass	
3.11	Glass blocks.	
3.12	Heat gain through glass.	
3.13	Problem solving	
4.	SIMPLE SATURATED CYCLE.	12 Hours
4.1	Vapor Compression System	
4.2	Division of System	
4.3	Vapor Compression Cycle	
4.3.1	Expansion process.	
4.3.2	Vaporizing process	
4.3.3	Compression process.	
4.3.4	Condensing process.	
4.4	Pressure enthalpy Diagram	
4.5	Simple Saturated Cycle on p-h Diagram	
4.6	Tracing of simple saturated cycle on pressure enthalpy chart (ph diagram) for R-12 and R-22, R410A, R32, R407C, R134a and R600a.	
4.7	Refrigerating Effect, Mass flow rate, heat of compression, latent heat rejected at condenser, sensible heat rejected at condenser, total heat rejected at condenser, coefficient of performance (COP), and compressor capacity in kW/HP calculations.	
4.8	Problem solving on ph chart.	
5.	ACTUAL REFRIGERATION CYCLE.	08 Hours
5.1	Deviation from the simple saturated cycle	
5.2	The effect of super heat the suction vapour.	
5.3	The effect of subcooling liquid.	
5.4	Change in refrigerating effect due to change in evaporator temperature/pressure.	
5.5	Change in refrigerating effect due to change in condensing temperature/pressure.	
5.6	The effect of pressure losses resulting from friction.	
5.7	Solving of problems on ph chart	
6.	PERFORMANCE/ EFFICIENCY OF REFRIGERATION CYCLE	8 Hours
6.1	Heat pump	
6.2	Refrigerating effect (RE) of heat pump	
6.3	Theoretical horse power of heat pump.	
6.4	Co-efficient of performance of heat pump	
6.5	Cycle efficiency of heat pump.	
6.6	Multistage compression	
6.6.1	Booster System	
6.6.2	Intercoolers	
6.6.3	Direct Staging Versus Cascade Staging	

- 7. SIZING AND SELECTION OF REFRIGERANT LINES & ASSECCORIES** 4 Hours
- 7.1 Sizing and selection of hot vapor line (Discharge line)
 - 7.2 Sizing of liquid line
 - 7.3 Liquid indicator and sight glass.
 - 7.4 Sizing and selection of expansion valve.
 - 7.5 Sizing and Selection of cooling coil in term of heat contents.
 - 7.6 Selection of suction line.
- 8. SORBENTS, DESICANTS & FUELS** 6 Hours
- 8.1 Sorbents
 - 8.2 Applications of Sorbents
 - 8.3 Absorbents and Adsorbents
 - 8.4 Solid & Liquid Absorbents
 - 8.5 Solid Adsorbents
 - 8.6 Purpose & classification of Fuels
 - 8.7 Combustion of Fuels
 - 8.8 An Analysis of Fuel by Weight and Volume
 - 8.9 Calorific Value of Fuels (Higher & Lower)
 - 8.10 Problem Solving

RECOMMENDED BOOKS:

- 1. Principle of Refrigeration by R.J. Dossat.
 - 2. Refrigeration, Air-conditioning & Cold storage by R.C.Gunther.
 - 3. Manual of Heat Transfer by Ministry of Education.
 - 4. ASHRAE Handbook- Fundamental & Equipment Volume
 - 5. Hear Transfer in Refrigeration Materials and Calculations (Manual), Ministry of Education , Islamabad.
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HVAC-362: HEAT TRANSFER AND REFRIGERATION CALCULATIONS

INSTRUCTIONAL OBJECTIVES

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

- 1. UNDERSTAND HEAT AND MASS TRANSFER.**
 - 1.1 Define heat transfer.
 - 1.2 Explain the methods of heat transfer, conduction, convection and radiation.
 - 1.3 State heat transfer by conduction through homogeneous and composite structures.
 - 1.4 Define Absorption, Reflection, Transmission, Black Body, Plank's Law, Kirchoff's Law, Emissivity and Absorptivity
 - 1.5 Define Mass Transfer
 - 1.5.1 Explain Mass transfer in HVAC
 - 1.5.2 Explain Moisture migration through walls and ducts
 - 2. UNDERSTAND TO DETERMINATE OVER ALL CO-EFFICIENT OF HEAT TRANSMISSION FACTOR.**
 - 2.1 Define thermal conductivity of materials.
 - 2.2 Define thermal conductance of material.
 - 2.3 Define thermal resistance of material.
 - 2.4 Determine the "U" factor by calculation and formulas.
 - 2.5 State "U" factor of insulated pipe.
 - 2.6 Explain the flow of heat through walls
 - 2.7 Describe the flow of heat through walls with varying outdoor temperatures.
 - 2.8 Solve problems.
 - 3. PROPERTIES OF INSULATORS AND CONDUCTORS.**
 - 3.1 Explain Insulation and their properties
 - 3.1.1 Thermal
 - 3.1.2 Mechanical
 - 3.2 Explain General building insulation practice
 - 3.2.1 Wood frame construction
 - 3.2.2 Steel frame construction
 - 3.2.3 Masonry frame construction
 - 3.3 Describe Heat Transfer Factors
 - 3.3.1 Fluid factor.
 - 3.3.2 Tube factor
 - 3.3.3 Temperature factor.
 - 3.3.4 Surface factor
 - 3.3.5 Designing factor.
 - 3.4 Explain general industrial insulation practice
 - 3.4.1 Pipes
 - 3.4.2 Ducts
 - 3.4.3 Tanks & Vessels
 - 3.5 Explain Heat surface area calculation for air cooled finned coil condenser
 - 3.6 Explain Heat surface area calculation for water cooled condenser
 - 3.7 Explain Heat surface area calculation for evaporator coil
 - 3.8 Define Common window glass
 - 3.9 Define Shade glass
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- 3.10 Define Other types of glass
- 3.11 Define Glass blocks.
- 3.12 Calculate Heat gain through glass.
- 3.13 Problem solving

4. SIMPLE SATURATED CYCLE.

- 4.1 Explain Vapor Compression System
- 4.2 Explain Division of System
- 4.3 Explain Vapor Compression Cycle
 - 4.3.1 Expansion process.
 - 4.3.2 Vaporizing process
 - 4.3.3 Compression process.
 - 4.3.4 Condensing process.
- 4.4 Explain Pressure enthalpy Diagram
- 4.5 Explain Simple Saturated Cycle on p-h Diagram
- 4.6 Trace simple saturated cycle on pressure enthalpy chart (ph diagram) for R-12 and R-22
- 4.7 Calculate Refrigerating Effect, Mass flow rate, heat of compression, latent heat rejected at condenser, sensible heat rejected at condenser, total heat rejected at condenser, coefficient of performance (COP), and compressor capacity in kW/HP calculations.
- 4.8 Problem solving on ph chart.

5. UNDERSTAND THE ACTUAL REFRIGERATION CYCLE

- 5.1 Explain deviation from the simple saturated cycle
- 5.2 Describe the effect of super heat the suction vapour.
- 5.3 Describe the effect of subcooling liquid.
- 5.4 Explain the change in refrigerating effect due to change in evaporator temperature/pressure.
- 5.5 Explain the change in refrigerating effect due to change in condensing temperature/pressure.
- 5.6 State the effect of pressure losses resulting from friction.
- 5.7 Solve problems on ph chart

6. UNDERSTAND THE PERFORMANCE/ EFFICIENCY OF REFRIGERATION CYCLE (HEAT PUMP)

- 6.1 Explain heat pump
- 6.2 Explain refrigerating effect (RE) of heat pump
- 6.3 State theoretical horse power of heat pump.
- 6.4 Define co-efficient of performance of heat pump
- 6.5 Describe the cycle efficiency of heat pump.
- 6.6 Explain the multistage compression (booster, intercooler)
- 6.7 Distinguish between direct staging and cascade staging

7. DETERMINE THE SIZING AND SELECTION OF CONDENSER, COOLING COIL AND REFRIGERANT LINES

- 7.1 Explain the procedure for sizing and selection of hot vapor line (discharge line)
 - 7.2 Explain the procedure for sizing of liquid line
 - 7.3 Explain the procedure for liquid indicator and sight glass.
 - 7.4 Explain the procedure for sizing and selection of expansion valve.
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7.6 Explain the procedure for selection of suction line.

8. SORBENTS, DESICANTS & FUELS

- 8.1 Describe Sorbents
 - 8.2 Applications of Sorbents
 - 8.3 Describe Absorbents and Adsorbents
 - 8.4 Describe Solid & Liquid Absorbents
 - 8.5 Describe Solid Adsorbents
 - 8.6 Describe Purpose & classification of Fuels
 - 8.7 Describe Combustion of Fuels
 - 8.8 Analysis of Fuel by Weight and Volume
 - 8.9 Describe Calorific Value of Fuels (Higher & Lower)
 - 8.10 Problem Solving
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HVAC-373: WORKSHOP PRACTICE-III

T	P	C
0	9	3

Total: 288 Hours

LIST OF PRACTICALS

On completion of the course, the trainees will be able to;

1. Inspect, install, and test a rooftop air conditioning system.
2. Inspect, install, and test a mini VRF system.
3. Inspect, install, and test a Fan Coil Unit (FCU).
4. Assemble, install, and test a cooling tower.
5. Diagnose and troubleshoot a window-type comfort cooler.
6. Diagnose and troubleshoot a heat pump.
7. Diagnose and troubleshoot a water chiller.
8. Inspect, install, and test a chilled water cooling system.
9. Inspect, install, and test a reach-in refrigeration cabinet.
10. Inspect, install, and test a low-temperature open-display refrigeration system.
11. Inspect, install, and test a walk-in cooler.
12. Inspect, install, and test a multi-temperature refrigeration system.
13. Inspect, install, and test an evaporative condenser or cooling tower.
14. Inspect, install, and test a remote air-cooled condenser.
15. Inspect, install, and test electrical and hot-gas defrost systems.
16. Diagnose and troubleshoot a hot-gas defrost hermetic refrigeration system.
17. Diagnose and troubleshoot a water-cooled refrigeration system.
18. Diagnose and troubleshoot an ice maker.
19. Diagnose and troubleshoot a low-temperature refrigeration system.
20. Diagnose and troubleshoot an evaporative cooler.
21. Draw the schematic diagram of a split air conditioning system.
22. Draw the schematic diagram of a packaged air conditioning system.
23. Determine the range, approach, and operating performance of a cooling tower.
24. Draw the system diagram of an air washer, including centrifugal fans, humidity controls, and circulating pumps.
25. Draw the system diagram of an air conditioning system incorporating a centrifugal fan, spray-type humidifier, direct expansion (DX) coil, filters, ductwork, compressor, heating coil, and control devices.
26. Perform overhauling and alignment of a centrifugal pump.
27. Draw the flow diagram of a chilled/hot water air conditioning system.
28. Inspect, install, and test chilled water and condenser water pumps.
29. Install, configure, and test a Variable Frequency Drive (VFD) for pump operation.

Note: 1: As required, visits to different air conditioning plants for the above PRACTICALS may be arranged otherwise may be performed in the lab if trainers and equipment are available at the institute

Note: 2: One full day may be dedicated for monthly field visits.

PROJECTS:

1. Remove, clean, install, and operate an oil separator.
2. Remove, clean or replace a thermostatic expansion valve (TXV) strainer.
3. Remove, test, install, and adjust a thermostatic expansion valve (TXV).
4. Dismantle, inspect, assemble, and test a two-temperature valve.
5. Evaluate the efficiency of a commercial refrigeration compressor.
6. Service a commercial refrigeration system.
7. Remove, inspect, and adjust a commercial pressure control.
8. Test and adjust a low-pressure cut-out control.
9. Install and calibrate pressure gauges on an externally driven refrigeration system.
10. Install and test a power humidifier in a duct system.
11. Operate and test a baseboard electric resistance heating system.
12. Measure noise levels using a sound level meter.
13. Install and adjust a water-regulating valve.
14. Remove, test, install, and adjust a pressure-operated water valve.
15. Inspect and test compressor motor electrical circuits.
16. Identify automotive air conditioning components and connect service gauges.
17. Perform an automotive air conditioning system performance test.

AIR CONDITIONING AND HEAT PUMP SIMULATION TROUBLESHOOTING:

Analyze, diagnose, and troubleshoot air conditioning and heat pump systems using computer simulation software. Students shall interpret system behavior, identify faults, recommend corrective actions, and document repair activities (fault activity, log-on time, repair actions, etc.).

The following simulated fault conditions shall be diagnosed:

- Diagnose refrigerant undercharge.
 - Diagnose refrigerant overcharge.
 - Diagnose a defective outdoor TXV power element.
 - Diagnose poor contact of the indoor TXV sensing bulb.
 - Diagnose a compressor that fails to start.
 - Diagnose a leaking outdoor check valve.
 - Diagnose a leaking indoor check valve.
 - Diagnose a reversing valve that fails to shift completely.
 - Diagnose a clogged indoor liquid-line filter drier.
 - Diagnose an excessively dirty indoor air filter.
 - Diagnose an excessively dirty indoor coil.
 - Diagnose restricted outdoor airflow.
 - Diagnose an indoor fan motor that fails to start.
 - Diagnose a broken compressor suction valve.
 - Diagnose air contamination in the refrigeration system.
 - Diagnose an open compressor run winding.
 - Diagnose shorted compressor run and start windings.
 - Diagnose a compressor start winding shorted to ground.
 - Diagnose an open compressor overload protector.
 - Diagnose a shorted compressor run capacitor.
 - Diagnose an open contactor coil.
 - Diagnose a high-resistance contactor contact (CC-1).
 - Diagnose an open outdoor fan motor winding.
 - Diagnose an open indoor fan motor run capacitor.
 - Diagnose an open reversing valve solenoid coil.
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- Diagnose an open defrost relay coil.
 - Diagnose a defrost thermostat stuck open.
 - Diagnose an open defrost timer motor winding.
 - Diagnose a defrost timer contact (DTC-1) stuck closed.
 - Diagnose a defrost relay contact (DFR-1) stuck open.
 - Diagnose an outdoor thermostat stuck open.
 - Diagnose an open transformer secondary winding.
 - Diagnose an open indoor fan relay coil.
 - Diagnose an indoor fan relay contact (IFR-1) stuck open.
 - Diagnose an open control wire (G).
 - Diagnose a heat thermostat (TSH) stuck closed.
 - Diagnose an open auxiliary heat relay (HR1) coil.
 - Diagnose an open auxiliary heater element (HTR2).
 - Diagnose an auxiliary heater limit switch (LS1) stuck open.
 - Diagnose the absence of line voltage at the outdoor unit.
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MGM-381 ENTREPRENEURSHIP

TOTAL CONTACT HOURS: 32

Theory: 32

Practical: 0

T	P	C
1	0	1

LEARNING OUTCOMES

The student will be able to understand the basics of entrepreneurship in relation to the architectural industry:

- Understand the fundamentals of small business enterprise
- Apply techniques for generating business ideas and assessing opportunities
- Understand the basic procedures for establishing a small business
- Identify essential financial record-keeping practices
- Develop a simplified business plan
- Apply entrepreneurship concepts in architectural planning and design

Course Contents

1. INTRODUCTION TO ENTREPRENEURSHIP (04 Hours)

- 1.1. Concept and Importance of Entrepreneurship
- 1.2. Key Terminologies
- 1.3. Types of Business: Social vs. Commercial
- 1.4. Motivation for Entrepreneurship: Benefits & Challenges

2. BUSINESS IDEA GENERATION (04 Hours)

- 2.1 Creativity and Innovation in Business
- 2.2 Sources of Business Ideas
- 2.3 Assessing Business Opportunities

3. ENTREPRENEURIAL CHARACTERISTICS (06 Hours)

- 3.1 Key Traits of Successful Entrepreneurs
- 3.2 Leadership and Decision-Making Skills
- 3.3 Principles of Business Negotiation

4. BASICS OF BUSINESS ESTABLISHMENT (06 Hours)

- 4.1 Market Overview: Demand, Competition, and Site Selection
- 4.2 Business Structures: Proprietorship and Small Enterprises
- 4.3 Basic Costing Concepts

5. ENTERPRISE MANAGEMENT (06 Hours)

- 5.1 Hiring and Managing Employees
- 5.2 Sales and Marketing Fundamentals
- 5.3 Financial Record Keeping Basics

6. BUSINESS PLANNING (06 Hours)

- 6.1 Purpose and Components of a Business Plan
 - 6.2 Feasibility Analysis
 - 6.3 Challenges in Small Business Startups
-

RECOMMENDED BOOKS

1. Dewhurst, J. (1996). Small business and entrepreneurship. London: Macmillan.
2. Drucker, P. & Maciariello, J. (2014). Innovation and entrepreneurship. Routledge.
3. Singh, P.N. (1986). Developing entrepreneurship for economic growth. Vikas.

Instructional Objectives**1. Understand the concept and elements of Entrepreneurship**

- 1.1 Define and explain entrepreneurship.
- 1.2 Differentiate business types.
- 1.3 Recognize entrepreneurial motivation factors.

2. Identify and assess business opportunities

- 2.1 Understand creativity in business.
- 2.2 Learn methods for business idea generation.
- 2.3 Assess business feasibility.

3. Recognize key entrepreneurial traits

- 3.1 Identify essential leadership and decision-making skills.
- 3.2 Apply negotiation techniques in business.

4. Understand basic procedures for business establishment

- 4.1 Market assessment and site selection.
- 4.2 Basic legal structures and financial needs.

5. Understand enterprise management techniques

- 5.1 Hiring procedures and staff management.
- 5.2 Basic marketing and financial management.

6. Develop a simplified business plan

- 6.1 Explain the need for a business plan.
 - 6.2 Conduct a basic feasibility study.
 - 6.3 Recognize potential startup challenges.
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BIBLIOGRAPHY

LIST OF PRESCRIBED BOOKS FOR REFRIGERATION & AIR-CONDITIONING

Sr. No	Name/Title of Book	Author	Publisher	Edition/Year
1	Modern Air-Conditioning Practice	Norman C. Harris	McGraw – Hill Book Co. New York	3 rd 1983
2	Trane Air-Conditioning Manual	Trane Company	The Trane Company La Crosse Winconsin	1984
3	Refrigeration, Air-Conditioning & Cold Storage	Raymond C. Gunther	Chilton Books, Philadelphia, New York	1957
4	Air-Conditioning Principles & Systems An Energy Approach	E.G. Pita	John Wiley & Sons, New York	1981
5	Principal of Air-conditioning	V.Paul Lang	CBS Publishers & Distributors, New Dehli, India	1 st 1987 or 1988
6	Principles of Refrigeration (S.I Version)	Roy J. Dossat	John Wiley & Sons Inc. New York	3 rd 1991
7	Air-Conditioning & Refrigeration	Severn & Fellows	Toppan Company Ltd. Tokyo, Japan (John Wiley & Sons Inc.)	1889
8	Sheet Metal Work	Robert. E. Smith	Meknight & Meknight Publichsing Co. Bloomington, Illinois	1952
9	Automatic Control of Heating and Air Conditioning	John E. Hains	McGrwe-Hill Book Co.Inc.	1961
10	Sheet Metal Shop Practice	Bruce & Meyer	D.B. Taraporevala Sons & Co. (Pvt) Ltd, Bombay (American Technical Society)	1972

11	Fundamentals of Pipe Drafting	Charles H. Thompson	John Wiley & Son, Inc. New Your	1958
12	Modern Refrigeration & Air Conditioning	Althouse Turnquist and Bracciano	The Goodheart-Wilcox Co.,Inc. South Holland, Illinois	1996
13	Refrigeration Principles & Systems	Edward G. Pita	John Wiley & Sons, New York	1984
14	Carrier System Design	Carrier Corporation	Carrier Air Conditioning Co. Syracuse, New York	1972
15	Control Systems for HVAC&R Controls	Roger W Haines	Van Nostrand Reinhold Co. New York, USA	3 rd
16	Refrigeration & Air Conditioning	Richard C.Jordan Gayle B. Priester	Prentice-Hall Inc. Englewood Cliffs, New Jersey, USA	2 nd 1974 1984
17	Refrigeration & Air Conditioning	W.F. Stoecker	McGraw-Hill Book Company Ltd	1984
18	ASHRAE Hand Book, 1977 Fundamental (S.I. Version)	ASHRAE	ASHRAE Inc., 345 East, 47 th Street, New York, USA	1977
19	ASHRAE Hand Book, 1986 Refrigeration systems & Applications (S.I. Version)	ASHRAE	ASHRAE Inc., 345 East, 47 th Street, New York, USA	1986
20	ASHRAE Handbook Equipment	ASHRAE	ASHRAE Inc., 345 East, 47 th Street, New York, USA	1988
21	Thermal Engineering	R.S. Khurmi J.K. Gupta	S.Chand & Company Ltd., New Delhi, India	1977
22	Carrier Hand Book	Carrier Corporation	McGraw Hill Book Co., London/Carrier Aircondiitoning Co. Syracus, New York, USA.	1965

23	Heat Engines	David A. Low	National Book Foundation, Pakistan	1963
24	App. Thermodynamics for Engineers	Eastops T.D. Meconkey	Longman London	6 th Edition
25	Basic Air conditioning	Schmaltzier; Gerald & Eveling	Hiayden Book Co., Inc., USA	1971
26	Refrigeration & Air-conditioning (SI Version)	W.F. Stoecker J.W. Jones	McGraw-Hill Int. 2 nd Edition	1982
27	Refrigeration & Air-conditioning (SI Version)	R.S. Khurmi J.K. Gupta	Eurasia Publishng House (Pvt) Ltd., Delhi	1998
28	Heat Pumps (Theory and Servicer)	Lee Miles	Delmar Publishers Inc.	-
29	Modern Refrigeration and Air Conditioning (Laboratory Manual)	Althouse / Turnquist / Brucciano	Goodheart Willcox Company, Inc. South Holland, Illinois.	1982
30	1 st year Engineering Drawing	A.C. Parkinson	Pitman, London.	1955
31	Building Construction	Arrora	Tata McGraw Hill Company, Delhi	1977
32	Simulator Training Program (User's and Instructor's Manual)	Simutech Multiuser Version 1.0x	Simutech	-
33	Heat Transfer in Refrigeration Materials and Calculations (Manual)	A.L. Jagru Rauf Ahmed Khan	Ministry of Education, Isl.	1987
34	Industrial Refrigeration Machines and Equipment (Manual)	Rahid Ahmed Shakir Zaidi	Ministry of Education, Isl.	1985

Proposed MINIMUM QUALIFICATION FOR TEACHER/INSTRUCTOR/JR. INSTRUCTOR

Post	Qualification	Experience
Jr. Instructor	DAE Fields: 1. HVACR Technology	4 Years
Instructor	BSc. Engineering/BE/ BSc.Tech Fields: 1. Mechanical Engineering	2 Years
Instructor	MSc. Engineering/MS/M.Tech Fields: 1. Mechanical Engineering 2. Thermal Engineering 3. Energy Systems Engineering	NIL

Other Supporting Subjects' Teachers

- i) A Master's degree in English / Islamiyat / Pakistan Studies with 2 years of teaching experience
 - ii) M.Sc. degree in IT / Computer Science or BE in Computer Engineering / Computer Sciences with 2 years of teaching experience
 - iii) M.Sc. degree in Mathematics with 2 years of teaching experience
 - iv) M.Sc. degree in Physics / Chemistry with 2 years of teaching experience
 - v) MBA / MBEcon. / BBA (Hons.) / BBIT degree with 2 years of teaching experience
-

Employability & Vertical Mobility of Occupations / Designations

(DAE HVACR Technology)

Government / Semi-Government Organizations:

- HVAC Technician
- Sub Engineer
- Associate Engineer
- HVAC Supervisor
- Assistant Manager (Maintenance)
- Deputy Manager (Mechanical/HVAC)
- Facility Manager

Departments may include:

- Public Works Department (PWD)
- Municipal Corporations
- Hospitals
- Universities
- Airports Authority
- Railways
- Corporate Sector
- Shopping Malls
- Automotive Sector
- Food Sector

Armed Forces (Engineering / EME / MES):

- HVAC Technician
- Engineering Technician
- Technical Supervisor
- Senior Technical Staff

Industrial Sector / Manufacturing Plants:

- Maintenance Technician
- HVAC Supervisor
- Plant Maintenance Engineer
- Utility Engineer
- Facility Maintenance Manager

Industries include:

- Textile Mills
- Cement Plants
- Pharmaceutical Industries
- Food Processing Units
- Oil & Gas Sector

Private Organizations & Multinational Companies:

- HVAC Technician
- Site Supervisor
- Project Coordinator
- Commissioning Engineer (with experience)
- Associate Engineer
- Project Manager (with experience)

Other Job Titles:

- AC Technician
 - Refrigeration Technician
 - Chiller Operator
 - Cold Storage Technician
 - Ducting Supervisor
 - Maintenance Supervisor
 - Building Services Technician
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