

DAE ELECTRICAL TECHNOLOGY (Revised-2020)

SCHEME OF STUDIES

1st YEAR

			T	P	C
GEN 111	Islamiat/Pakistan Studies		1	0	1
ENG 112	English	2	0	2	
MATH123	Applied Mathematics-I		3	0	3
CH 132	Applied Chemistry		1	3	2
Comp 162	Computer Applications		1	3	2
ET 125	Principles of Electrical Engineering		3	6	5
ET 131	Basic Electrical Drawing		0	3	1
ET 143	Workshop Practice (Electrical)		1	6	3
ET 153	Work Shop Practice (Mechanical)		0	9	3
	i) Metal Work	0 3 1			
	ii) Welding	0 3 1			
	iii) Machine Shop	0 3 1			
	T o t a l		12	30	22

2nd YEAR

			T	P	C
GEN 211	Islamiat & Pakistan Studies		1	0	1
MATH233	Applied Mathematics-II		3	0	3
PHY 222	Applied Physics		1	3	2
MGM 221	Business Management & Industrial Economics		1	0	1
ET 203	D.C. Machines & Batteries		2	3	3
ET 273	Electrical Instruments & Measurements		2	3	3
ET 253	Utilization of Electrical Energy		2	3	3
ET 252	Electrical Installation Planning & Estimating		1	3	2
ET 261	Applications of Computers in Electrical Tech.		0	3	1
ET 283	Basic Electronics		2	3	3
ET 282	Digital Logic Design		1	3	2
	T o t a l		16	24	24

3rd YEAR

			T	P	C
GEN 311	Islamiat/Pakistan Studies		1	0	1
MGM 321	Business Communication		1	0	1
MGM 311	Industrial Management & Human Relations		1	0	1
ET 326	A.C. Machines		4	6	6
ET 332	Power Plant & Energy Conservation		2	0	2
ET 345	Transmission, Distribution and Protection of Electrical Power Systems		4	3	5
ET 303	Telecommunication		2	3	3
ET 363	Repair & Maintenance of Electrical Equipment		1	6	3
ET 373	Industrial Electronics		2	3	3
	T o t a l		18	21	25
	Grand Total		46	75	71

اسلامیات / مطالعہ پاکستان

ٹی پی سی
1 0 1
کل وقت: 20 گھنٹے

GEN III

سال اول

حصہ اول اسلامیات

حصہ دوم مطالعہ پاکستان

موضوعات حصہ اول اسلامیات

کتاب و سنت

(ا) قرآن مجید

1- تلواریف 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 یامرکم ان تؤدوا الامانات الی اهلها
- 1.5 ان اللہ یامر بالعدل والاحسان
- 1.6 ان الصلوة تنهی عن الفحشاء والمنکر
- 1.7 لقد کان لکم فی رسول اللہ سوة حسنة
- 1.8 ان اکرمکم عند اللہ اتقاکم
- 1.9 وما آتاکم الرسول فخرزوه وما نهی عنہوا نتهوا
- 1.10 ولوفوا بالعہد
- 1.11 وما شروہن بالمعروف
- 1.12 یمحق اللہ الربو ویربب الصمدقات
- 1.13 واصبر علی ما اصابک
- 1.14 وقولوا قولا سدیداً
- 1.15 ان الدین عند اللہ السلام

(ب) سنت

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

- 1- اعمال اعمال بالنیات
- 2- اہمیت لایتم مکارم الاخلاق
- 3- لایوم من احدکم حق یحب الاخیہ ما یحب لنفسه
- 4- المسلم من سلم المسلمون من سبہ المسمون من لسانہ ویدہ
- 5- فی امنت باللہ سلم استقم
- 6- حیرکم خیرکم ذالہ
- 7- سبب المسلم فسوق وقتالہ کفر
- 8- المؤمن اخو المؤمن
- 9- کل المسلم عسی المسلم حیر لم یجمعہ ووالہ وفرقہ
- 10- ایتہ المنلق ثلاث اذا حدیث کذب وفاقا وتمن خان وانا وفنا خلف

دین اسلام

2.1 ہمنام کے بنیادی مقصد کن وضاحت اور انسان کی اخروی و دنیاوی زندگی پر ان کے اثرات

- 1- توبہ
 - 2- رسالت
 - 3- آخرت
 - 4- ملاک
 - 5- آسماں شب
- 2.2 عبادات

1- نماز 2- روزہ 3- حج 4- زکوٰۃ

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

تدریسی 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

- ۱۰ قرآن مجید کی تعریف کر سکے گا
- ۱۱ قرآن مجید کے نزول کی صورت بیان کر سکے
- ۱۲ قرآن مجید کی آئی و مدنی سورتوں کی پہچان کر سکے
- ۱۳ منتخب آیات کا ترجمہ و تشریح کر سکے
- عمومی مقصد: یہ سمجھنے کے قابل ہو جائے گا کہ منتخب قرآنی آیات کے ذریعے اسلامی تعلیمت کا مفہوم کیا ہے
- ۱۴ قرآنی آیات کا ترجمہ تشریح کر سکے
- ۱۵ قرآنی تعلیمت کی روشنی میں اپنی اور معاشرتی اصلاح کر سکے

۲۔ سنت

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

- ۱۶ سنت کی تعریف بیان کر سکے
- ۱۷ سنت کی اہمیت و ضرورت کی وضاحت کر سکے
- ۱۸ سنت کی روشنی میں مسوود حسنہ پر عمل کر سکے
- ۱۹ منتخب احادیث نبویہ
- عمومی مقصد: احادیث کی روشنی میں اخلاقی اقدار سے سمجھنی حاصل کر سکے
- خصوصی مقصد: احادیث کا ترجمہ و تشریح کر سکے
- رسول اللہ ﷺ کے مسوود حسنہ کا ترجمہ، کلمہ مدعا ہو سکے

دین اسلام

عمومی مقاصد: دین اسلامی کے بنیادی مقاصد اور عبادت کے بارے میں جان سنے 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 اخروی 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 نسلی زندگی پر ان کی اثرات بیان کر سکے

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

انجیر مسلم طلباء کے لئے

GEN III

نئی نئی
1 0 1
کل وقت - 20 منٹ

موضوعات

نصاب اختلاقیات سائنسوں
حصہ دوم ملاحظہ پاکستان

اختلاقیات کی تعریف اور اہمیت
اختلاقیات کا معیار (آٹون، عقل، الحی، کسب)

سندرجہ اہل اخلاقیات کی وضاحت

☆ ہونٹ ارشاد

☆ وہ داری

☆ نظم و ضبط

☆ راست گوئی

☆ صبر و استقلال

☆ جوصلہ بندی

☆ وقت کی پابندی

☆ سفاکی

☆ اعتدال

☆ پابندی احرام

☆ مصلحت

نصاب اخلاقیات (سائنسوں)

تعمیری مقاصد

- عمومی مقاصد: اعلیٰ تعلقات کی وجہ سے ملکی ترقی میں تھقل قدر اضافہ کر سکے
- خصوصی مقاصد: طلبہ اس علم سے اس قدر متاثر ہو سکیں کہ
- ۱۵ موضوعات کا مطلب بیان کر سکے
- ۱۶ عملی زندگی سے مثالوں کی نشان دہی 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 لقم و حیلہ کی فلاحیت بیان کر سکے
- ۲۱ صدق بیان کی ضرورت بیان کر سکے
- ۲۲ حوصلہ مندی کے فوائد بیان کر سکتے
- ۲۳ برکت کی پابندی کے فوائد بیان کر سکے
- ۲۴ صفائی اور باہمی اختیار سے حسن کلرکھی کو بیان کر سکے
- ۲۵ مصلحت کے فوائد بیان کر سکے

نصاب: سال اول (Gen III)

کل وقت 12 گھنٹے

مذاہب پاکستان

حصہ دوم

موضوعات

1. حضرت نوح: سسوں قوم میں آزادی فکر کی تاریخ مسلمانوں میں سیاسی آزادی کی اہمیت اور ضرورت۔ ذاتی و
جسٹس، غلامی کے تعلقات
2. نظریہ پاکستان
3. قیام پاکستان کی اساس (ذہن اسد) قیام پاکستان کی فرض اہمیت نظریہ پاکستان کی وضاحت۔ نظریہ پاکستان اور صدر
اقبال اور قائد اعظم کے ارشادات کی روشنی میں
4. نظریہ پاکستان کا تاریخی پسو
5. مہرین قاسم کی آواز، مجید تلف مہنی اور شہ اہل ایشیہ کی تباہی عدالت سید احمد شہید کی تحریک مجاہدین
6. قاسم کی تحریک
7. علی گڑھ - عدوت احمدیہ (بیروت - مدرسہ الامام - سندھ) اسلامیہ کالج (پٹنور) انجمن حملت اسام (انور)

مطالعہ پاکستان (حصہ دوم)

تدریسی مقاصد

حریت فکر:

عمومی مقصد

طالب علم یہ جان لے کہ اسلام میں اور مسلمان قوم میں آزادی فکری کیا اہمیت ہے

خصوصی مقاصد

۱۴ حریت فکر کا معنی و مفہوم بیان کر سکے

۱۵ آزادی فکری اہمیت بیان کر سکے

۱۶ خصوصاً "اسلام میں آزادی اظہار رائے" کی اہمیت بیان کر سکے

۱۷ ذہنی غلامی کے قومی سطح پر نقصانات کے بیان کر سکے

۱۸ ذہنی غلامی قومی سطح پر نقصانات بیان کر سکے

نظریہ پاکستان

عمومی مقصد:

نظریہ پاکستان (دوین اسلام) سے پوری طرح واقفیت ہو جائے

خصوصی مقاصد:

۱۹ نظریہ کی تعریف بیان کر سکے اور اس کی وضاحت کر سکے

۲۰ نظریہ پاکستان کی تعریف کر سکے اور اس کا مفہوم بیان کر سکے

۲۱ علامہ اقبال اور قائد اعظم کے فرمودات کی روشنی میں نظریہ پاکستان بیان کر سکے

نظریہ پاکستان کا تاریخی پسو

عمومی مقصد

۲۲ نظریہ پاکستان کے تاریخی پس منظر سے واقفیت حاصل کر سکے

خصوصی مقاصد:

۲۳ محمد بن قاسم کے بارے میں بیان کر سکے

- ۶۳ محمد بن قاسم کے ہندوستان پر حملہ کی وجہ بیان کر سکتے
- ۶۴ محمد بن قاسم کے ہندوستان پر حملہ کے اثرات بیان کر سکتے
- ۶۵ بیان کر سکتے کہ ہندوستان میں ہندو مسلمہ دو قومیں نظر یہ لاکتہ آغاز کیا ہے
- ۶۶ مہدالف ثانی کی علمی خدمات بیان کر سکتے
- ۶۷ شہاد علی اللہ کی علمی خدمات بیان کر سکتے
- ۶۸ مہدالف ثانی اور شہاد علی اللہ نے جو تبلیغ دین اور مسلمانوں میں سہاوی شعور پیدا کیا اسے بیان کر سکتے

علمی تحریکیں

- ۶۹ علمی مقصد
- ۷۰ برصغیر کی علمی تحریکوں سے آگاہی حاصل کر سکتے
- ۷۱ خصوصاً مرقعہ:
- ۷۲ علی گڑھ - دیوبند - تحریک العلماء مدرسہ السلام، اسلامیہ کالج - انجمن حنیفہ اسلام نے تعلیم کے ذریعہ سیاسی شعور مسلمانوں میں پیدا کیا اسے بیان کر سکتے
- ۷۳ آذربائی ہند کے سلسلہ میں تحریک مہذبین کی خدمات بیان کر سکتے

ENG-112 ENGLISH

Total Contact Hours

Theory	64	T	P	C
Practical	0	2	0	2

AIMS 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 | 10 hours |
| 5.1 | Translation from Urdu into English.
For Foreign Students: A paragraph or a dialogue. | |

RECOMMENDED TEXT BOOK

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-123 APPLIED MATHEMATICS-I

Total Contact Hours		T	P	C
Theory	96	3	0	3
Practical	0			

AIMS After completing the course, the students will be able to solve problems of Algebra, Trigonometry, Vectors, Boolean Algebra, Complex numbers and Analytic Geometry, develop skills in the use of mathematical instruments and acquire mathematical clarity and insight in the solution of technical problems.

COURSE CONTENTS

- 1. QUADRATIC EQUATIONS** **6 hours**
 - 1.1 Standard Form
 - 1.2 Solution
 - 1.3 Nature of roots
 - 1.4 Sum and product of roots
 - 1.5 Formation
 - 1.6 Problems

- 2. BINOMIAL THEOREM** **6 hours**
 - 2.1 Factorials
 - 2.2 Binomial expression
 - 2.3 Binomial co-efficient
 - 2.4 Statement
 - 2.5 The general term
 - 2.6 The binomial series
 - 2.7 Problems.

- 3. PARTIAL FRACTIONS** **6 hours**
 - 3.1 Introduction
 - 3.2 Linear distinct factors case I
 - 3.3 Linear repeated factors case II
 - 3.4 Quadratic distinct factors case III
 - 3.5 Quadratic repeated factors case IV
 - 3.6 Problems

- 4. FUNDAMENTALS OF TRIGONOMETRY** **6 hours**
 - 4.1 Angles
 - 4.2 Quadrants
 - 4.3 Measurements of angles
 - 4.4 Relation between sexagesimal and circular system
 - 4.5 Relation between length of a circular arc and the radian measure of its central angle
 - 4.6 Problems

5.	TRIGONOMETRIC FUNCTIONS AND RATIOS	6 hours
5.1	Trigonometric functions of any angle	
5.2	Signs of trigonometric functions	
5.3	Trigonometric ratios of particular angles	
5.4	Fundamental identities	
5.5	Problems	
6.	GENERAL IDENTITIES	6 hours
6.1	The Fundamental Law	
6.2	Deductions	
6.3	Sum and difference formulae	
6.4	Double angle identities	
6.5	Half angle identities	
6.6	Conversion of sum or difference to products	
6.7	Problems	
7.	SOLUTION OF TRIANGLES	6 hours
7.1	The law of Sines	
7.2	The law of Cosines	
7.3	Measurement of heights and distances	
7.4	Problems	
8.	VECTORS AND PHASORS	12 hours
8.1	Scalars and Vectors	
8.2	The unit Vectors i, j, k	
8.3	Direction Cosines	
8.4	Dot product	
8.5	Cross product	
8.6	Analytic expressions for dot and cross products	
8.7	Phasors	
8.8	Significance of j operator	
8.9	Different forms	
8.10	Algebraic operations	
8.11	Problems	
9.	COMPLEX NUMBERS	9 hours
9.1	Introduction and properties	
9.2	Basic operations	
9.3	Conjugate	
9.4	Modulus	
9.5	Different forms	
9.6	Problems	
10.	BOOLEAN ALGEBRA AND GATE NETWORKS	15 hours

- 10.1 Concept and basic laws
- 10.2 Sums of product and product of sums
- 10.3 Binary, decimals and octals, presentation of decimal numbers in BCD
- 10.4 Inter-conversion of numbers
- 10.5 OR Gates and AND Gates
- 10.6 Logical Expressions and their simplification
- 10.7 Demorgan's theorems
- 10.8 NAND Gates and NOR Gates
- 10.9 Problems

11. PLANE ANALYTIC GEOMETRY AND STRAIGHT LINE 6 hours

- 11.1 Coordinate system
- 11.2 Distance formula.
- 11.3 Ratio formulas.
- 11.4 Inclination and slope of line.
- 11.5 Slope formula.
- 11.6 Problems.

12. EQUATIONS OF THE STRAIGHT LINE 6 hours

- 12.1 Some important forms
- 12.2 General form
- 12.3 Angle formula.
- 12.4 Parallelism and perpendicularity
- 12.5 Problems

13. EQUATIONS OF THE CIRCLE. 6 hours

- 13.1 Standard and Central forms of equation.
- 13.2 General form of equation.
- 13.3 Radius and coordinates of center.
- 13.4 Problems

RECOMMENDED TEXT BOOK

1. Applied Mathematics: Math-123, Developed by Nasir -ud-Din Mahmood, Sana-ullah Khan, Tahir Hameed, Evaluated by Syed Tanvir Haider, Javed Iqbal, Vol - I, National Book Foundation

MATH-123 APPLIED MATHEMATICS-I

INSTRUCTIONAL OBJECTIVES

- 1.2 USE DIFFERENT METHODS FOR THE SOLUTION OF QUADRATIC EQUATION**
 - 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 the sum and product of the roots.
 - 1.7 Form a quadratic equation from the given roots.
 - 1.8 Solve problems involving quadratic equations.

- 2. APPLY BINOMIAL THEOREM FOR THE EXPANSION OF BINOMIAL AND EXTRACTION OF ROOTS.**
 - 2.1 State binomial theorem for positive integral index.
 - 2.2 Explain binomial coefficients:
(n,0), (n,1).....(n,r)....., (n,n)
 - 2.3 Derive expression for the general term.
 - 2.4 Calculate the specified terms.
 - 2.5 Expand a binomial of a given index.
 - 2.6 Extract the specified roots.
 - 2.7 Compute the approximate value to a given decimal place.
 - 2.8 Solve problems involving binomials.

- 3. APPLY DIFFERENT METHODS FOR RESOLVING A SINGLE FRACTION INTO PARTIAL FRACTIONS USING DIFFERENT METHODS**
 - 3.1 Define a partial fraction, a proper and an improper fraction.
 - 3.2 Explain all the four types of partial fractions.
 - 3.3 Set up equivalent partial fractions for each type.
 - 3.4 Explain the methods for finding constants involved.
 - 3.5 Resolve a single fraction into partial fractions.
 - 3.6 Solve problems involving all the four types.

- 4. UNDERSTAND THE SYSTEMS OF MEASUREMENT OF ANGLES.**
 - 4.1 Define angles and the related terms.
 - 4.2 Illustrate the generation of an angle.
 - 4.3 Explain sexagesimal and circular systems for the measurement of angles.
 - 4.4 Derive the relationship between radian and degree.
 - 4.5 Convert radians to degrees and vice versa.
 - 4.6 Derive a formula for the circular measure of a central angle.
 - 4.7 Use this formula for solving problems.

- 5. UNDERSTAND BASIC CONCEPTS AND PRINCIPLES OF TRIGONOMETRIC**

FUNCTIONS.

- 5.1 Define the basic trigonometric functions/ratios of an angle as ratios of the sides of a right triangle.
- 5.2 Derive fundamental identities.
- 5.3 Find trigonometric ratios of particular angles.
- 5.4 Draw the graph of trigonometric functions.
- 5.5 Solve problems involving trigonometric functions.

6. USE TRIGONOMETRIC IDENTITIES IN SOLVING TECHNOLOGICAL PROBLEMS.

- 6.1 List fundamental identities.
- 6.2 Prove the fundamental law.
- 6.3 Deduce important results.
- 6.4 Derive sum and difference formulas.
- 6.5 Establish half angle, double and tripple angle formulas.
- 6.6 Convert sum or difference into product and vice versa.
- 6.7 Solve problems.

7. USE CONCEPT, PROPERTIES AND LAWS OF TRIGONOMETRIC FUNCTIONS FOR SOLVING TRIANGLES.

- 7.1 Define angle of elevation and angle of depression.
- 7.2 Prove the law of sines and the law of cosines.
- 7.3 Explain elements of a triangle.
- 7.4 Solve triangles and the problems involving heights and distances.

8. UNDERSTAND PRINCIPLES OF VECTORS AND PHASORS

- 8.1 Define unit vectors i, j, k .
- 8.2 Express a vector in the component form.
- 8.3 Explain magnitude, unit vector, direction cosines of a vector.
- 8.4 Explain dot product and cross product of two vector.
- 8.5 Deduce important results from dot and cross product.
- 8.6 Define phasor and operator j .
- 8.7 Explain different forms of phasors.
- 8.8 Perform basic Algebraic operation on phasors.
- 8.9 Solve problems on phasors.

9. USE PRINCIPLES OF COMPLEX NUMBERS IN SOLVING TECHNOLOGICAL PROBLEMS.

- 9.1 Define a complex number and its conjugate.
- 9.2 State properties of complex numbers.
- 9.3 Give different forms of complex numbers.
- 9.4 Perform basic algebraic operations on complex numbers.
- 9.5 Solve problem involving complex numbers.

10. SOLVE TECHNICAL PROBLEMS USING PRINCIPLES OF BOOLEAN ALGEBRA

- 10.1 Explain fundamental concepts of boolean algebra

- 10.2 Explain binary numbers, octal numbers, decimal numbers and their interconversion.
- 10.3 Explain digital addition and multiplication and its applications to OR gates and AND Gates
- 10.4 Illustrate complimentation and inversion
- 10.5 Evaluate logical expression
- 10.6 List basic Laws of Boolean Algebra
- 10.7 Explain De-Morgan's theorem
- 10.8 Explain basic duality of boolean algebra
- 10.9 Derive boolean expression
- 10.10 Explain combination of GATES
- 10.11 Illustrate sum of products and product of sum
- 10.12 Derive product of sum expression
- 10.13 Explain NAND Gates and NOR Gates
- 10.14 Use the map methods for simplifying expressions
- 10.15 Explain sub-cubes and covering

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 Describe the ratio formula
- 11.5 Derive slope formula
- 11.6 Solve problems using the above formulae.

12. USE EQUATIONS OF STRAIGHT LINE IN SOLVING PROBLEMS.

- 12.1 Define equation of a straight line.
- 12.2 Derive slope intercept and intercept forms of equations of a straight line.
- 12.3 Write general form of equations of a straight line.
- 12.4 Derive an expression for angle between two straight lines.
- 12.5 Derive conditions of perpendicularity and parallelism of two straight lines.
- 12.6 Solve problems using these equations/formulae.

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.
- 13.4 Deduce formula for radius and coordinates of the center of a circle.
- 13.5 Derive equation of the circle passing through three points.
- 13.6 Solve problems involving these equations.

CH-132 APPLIED CHEMISTRY

Total Contact Hours		T	P	C
Theory	32	1	3	2
Practical	96			

Pre-requisite: The student must have studied the subject of elective chemistry at Secondary school level.

AIMS After studying this course a student will be able to:

1. Understand the significance and role of chemistry in the development of modern technology.
2. Becomes acquainted with the basic principles of chemistry as applied in the study of relevant Technology.
3. Knows the scientific methods for production, properties and use of materials of industrial & technological significance.
4. Gain skill for the efficient conduct of practicals in a chemistry lab.

1. INTRODUCTION 2 Hours

- 1.1 The scope and significance of the subject.
- 1.2 Orientation with reference to Technology.
- 1.3 Terms used & units of measurements in the study of chemistry.

2. FUNDAMENTAL CONCEPTS OF CHEMISTRY 2 Hours

- 2.1 Symbols, Valency, Radicals, formulas.
- 2.2 Chemical Reactions & their types.
- 2.3 Balancing of equations by ionic method.

3. ATOMIC STRUCTURE 2 Hours

- 3.1 Sub-atomic particles.
- 3.2 Bohrs Atomic Model.
- 3.3 The periodic classification of elements and periodic law
- 3.4 General characteristics of a period and group.

4. CHEMICAL BOND 2 Hours

- 4.1 Nature of chemical Bond.
- 4.2 Electrovalent bond with examples.
- 4.3 Covalent Bond(Polar and Non-polar, sigma & Pi Bonds with examples.
- 4.4 Co-ordinate Bond with examples.

5. SOLIDS AND LIQUIDS 3 Hours

- 5.1 The liquid and Solids state.
- 5.2 The liquids and their general properties (Density, viscosity, surface tension capillary action etc).
- 5.3 Solids and their general properties.
- 5.4 Crystal structure of solids

5.5 Crystals of Si and Ge.

- 6. WATER** **3 Hours**
- 6.1 Chemical nature and properties.
 - 6.2 Impurities.
 - 6.3 Hardness of water (types, causes & removal)
 - 6.4 Scales of measuring hardness (Degrass Clark, French, PPM, Mgm per litre).
 - 6.5 Boiler feed water, scales and treatment.
 - 6.6 Sea-water desalination, sewage treatment.
- 7. ACIDS, BASES AND SALTS** **2 Hours**
- 7.1 Definitions with examples.
 - 7.2 Properties, their strength, basicity & Acidity.
 - 7.3 Salts and their classification with examples.
 - 7.4 pH-value and scale.
- 8. OXIDATION & REDUCTION** **2 Hours**
- 8.1 The process with examples.
 - 8.2 Oxidizing and Reducing agents.
 - 8.3 Oxides and their classifications.
- 9. NUCLEAR CHEMISTRY** **2 Hours**
- 9.1 Introduction.
 - 9.2 Radioactivity (Alpha, beta and gamma rays).
 - 9.3 Half life process.
 - 9.4 Nuclear reaction & transformation of elements.
 - 9.5 Isotopes and their uses.
- 10. ALLOYS** **2 Hours**
- 10.1 Introduction with need.
 - 10.2 Preparation and properties.
 - 10.3 Some important alloys and their composition.
- 11. CORROSION** **2 Hours**
- 11.1 Introduction with causes.
 - 11.2 Types of corrosion.
 - 11.3 Rusting of Iron
 - 11.4 Protective measures against corrosion.
- 12. ELECTRO CHEMISTRY** **2 Hours**
- 12.1 Ionization and Arrhenius theory of Ionization.
 - 12.2 Electrolytes and Electrolysis.
 - 12.3 Faraday's Laws and numericals related to them.
 - 12.4 Application of Electrolysis (Electron, lathing etc).
 - 12.5 Electro Chemical cells.

- 13. ELECTRICAL INSULATING MATERIALS. 2 Hours**
- 13.1 Introduction.
 - 13.2 Solid insulators with chemical nature.
 - 13.3 Liquid insulators with chemical nature.
 - 13.4 Gaseous insulators with chemical nature.
 - 13.5 Uses and their classification.
- 14. SEMI CONDUCTORS. 2 Hours**
- 14.1 Introduction
 - 14.2 Atomic structure of silicon and germanium.
 - 14.3 Bonding & Conductivity.
 - 14.4 Energy bands in a semiconductor.
- 15. ETCHING PROCESS. 2 Hours**
- 15.1 The process and its aims.
 - 15.2 Etching reagents.
 - 15.3 Applications of processors.

RECOMMENDED BOOKS

1. Text Book of Ch-132, Vol-I, developed by Curriculum Section, Academics wing TEVTA and published by National Book Foundation (NBF)

CH-132 APPLIED CHEMISTRY

INSTRUCTIONAL OBJECTIVES

- 1. UNDERSTAND THE SCOPE, SIGNIFICANCE AND ROLE OF THE SUBJECT.**
 - 1.1 Define chemistry and its terms.
 - 1.2 Define the units of measurements in the study of chemistry.
 - 1.3 Explain the importance of chemistry in various fields of specialization.
 - 1.4 Explain the role of chemistry in this technology.

- 2. UNDERSTAND LANGUAGE OF CHEMISTRY AND CHEMICAL REACTIONS.**
 - 2.1 Define symbol, valency, radical, formula with examples of each.
 - 2.2 Write chemical formula of common compounds.
 - 2.3 Define chemical reaction and equations.
 - 2.4 Describe types of chemical reactions with examples.
 - 2.5 Explain the method of balancing the equation by ionic method.

- 3. UNDERSTAND THE STRUCTURE OF ATOMS AND ARRANGEMENT OF SUB ATOMIC PARTICLES IN THE ARCHITECTURE OF ATOMS.**
 - 3.1 Define atom.
 - 3.2 Describe the fundamental sub atomic particles
 - 3.3 Distinguish between atomic no. mass no. and between isotope and isobars.
 - 3.4 Explain the arrangements of electrons in different shells and sub energy levels and understand bohr's atomic model.
 - 3.5 Explain the grouping and placing of elements in the periodic table especially Si & germanium.
 - 3.6 State the periodic law of elements.
 - 3.7 Explain the trend of properties of elements based on their position in the periodic table.
 - 3.8 Explain general characteristics of a period and a group.

- 4. UNDERSTAND THE NATURE OF CHEMICAL BONDS.**
 - 4.1 Define chemical Bond.
 - 4.2 State the nature of chemical bond.
 - 4.3 Differentiate between electrovalent and covalent bonding.
 - 4.4 Explain the formation of polar and non polar, sigma and pi-bond with examples.
 - 4.5 Describe the nature of coordinate bond with examples.

- 5. UNDERSTAND THE STATES OF MATTER AND DISTINGUISHES SOLIDS FROM GASES.**
 - 5.1 Describe the liquid and solid states of matter.
 - 5.2 State the general properties of liquid.
 - 5.3 State the general properties of solid.
 - 5.4 Explain the formation of crystals and their types.
 - 5.5 Describe the crystal structure of Si and Ge.

- 6. UNDERSTAND THE CHEMICAL NATURE OF WATER.**

- 6.1 Describe the chemical nature of water with its formula.
- 6.2 Describe the general impurities present in water.
- 6.3 Explain the causes and methods to remove hardness of water.
- 6.4 Express hardness in different units like mg/litre, p.p.m, degrees Clark and degrees French.
- 6.5 Describe the formation and nature of scales in boiler feed water.
- 6.6 Explain the method for the treatment of scales.
- 6.7 Explain the sewage treatment and desalination of sea water.

7. UNDERSTAND THE NATURE OF ACIDS, BASES AND SALTS.

- 7.1 Define acids, bases and salts with examples.
- 7.2 State general properties of acids and bases.
- 7.3 Differentiate between acidity and basicity.
- 7.4 Define salts, give their classification with examples.
- 7.5 Explain pH value of solution and pH scale.

8. UNDERSTAND THE PROCESS OF OXIDATION AND REDUCTION.

- 8.1 Define oxidation.
- 8.2 Illustrate the oxidation process with examples.
- 8.3 Define reduction.
- 8.4 Explain reduction process with examples.
- 8.5 Define oxidizing and reducing agents and give at least six examples of each.
- 8.6 Define oxides.
- 8.7 Classify the oxides and give examples.

9. UNDERSTAND THE FUNDAMENTALS OF NUCLEAR CHEMISTRY.

- 9.1 Define nuclear chemistry and radio activity.
- 9.2 Differentiate between alpha, beta and gamma particles.
- 9.3 Explain half life process.
- 9.4 Explain at least six nuclear reactions resulting in the transformation of some elements.
- 9.5 State the uses of isotopes.

10. UNDERSTAND THE NATURE OF ALLOYS USED IN THE RESPECTIVE TECHNOLOGY.

- 10.1 Define alloy.
- 10.2 Explain different methods for the preparation of alloys.
- 10.3 Explain important properties of alloys.
- 10.4 Explain the composition, properties and uses of alloys.

11. UNDERSTAND THE PROCESS OF CORROSION.

- 11.1 Define corrosion.
- 11.2 Describe different types of corrosion.
- 11.3 State the causes of corrosion.
- 11.4 Explain the process of rusting of iron.
- 11.5 Describe methods to prevent/control corrosion.

12. UNDERSTAND THE APPLICATION OF ELECTROCHEMISTRY IN DIFFERENT

FIELDS OF INDUSTRIES.

- 12.1 Define ionization, electrolyte and electrolysis.
- 12.2 Describe Arrhenius theory of ionization.
- 12.3 State Faraday's laws of electrolysis.
- 12.4 Apply Faraday's laws of different fields of industry.
- 12.5 Solves numerical problem on Faraday's Laws.
- 12.6 Explain the construction and working of Daniel cell and lead accumulator.

13. KNOW THE USE OF INSULATING MATERIALS.

- 13.1 Define insulator, conductor.
- 13.2 Classify solid, liquid and gaseous insulators with their chemical nature.
- 13.3 Describe their uses.

14. UNDERSTAND THE NATURE AND CHEMISTRY OF SEMI CONDUCTORS.

- 14.1 Define semi conductors.
- 14.2 Draw the atomic structure of silicon and germanium.
- 14.3 Describe the process of bonding and conductivity in conductors and semi conductors.
- 14.4 Explain energy bands in semi conductors.

15. USE ETCHING PROCESS IN DIFFERENT FIELDS OF TECHNOLOGY.

- 15.1 Define etching process and its aims.
- 15.2 Enlist the chemicals/reagents used in the process.
- 15.3 Explain the use of the process in the technology.

LIST OF PRACTICALS

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 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.
11. To get introduction with the scheme of analysis of salts for basic radicals.
12. To analyse 1st group radicals (Ag^+ - Pb^{++} - Hg^+).
13. To make practice for detection 1st group radicals.
14. To get introduction with the scheme of II group radicals.
15. To detect and confirm II-A radicals (Hg^{++} , Pb^{++++} , Cu^+ , Cd^{++} , Bi^{+++}).
16. To detect and confirm II-B radicals Sn^{+++} , Sb^{+++} , As^{+++}).
17. To get introduction with the scheme of III group radicals (Fe^{+++} - Al^{+++} , Cr^{+++})
18. To detect and confirm Fe^{+++} , Al^{+++} and Cr^{+++} .
19. To get introduction with the scheme of IV group radicals.
20. To detect and confirm An^{++} and Mn^{++} radicals of IV group.
21. To detect and confirm Co^{++} and Ni^{++} radicals of IV group.
22. To get introduction with the Acid Radical Scheme.
23. To detect dilute acid group.
24. To detect and confirm CO_3^{--} and HCO_3^- radicals.
25. To get introduction with the methods/apparatus of conducting volumetric estimations.
26. To prepare standard solution of a substance.
27. To find the strength of a given alkali solution.
28. To estimate HCO_3^- contents in water.
29. To find out the %age composition of a mixture solution of KNO_3 and KOH volumetrically.
30. To find the amount of chloride ions (Cl^-) in water volumetrically.

COMP-162 COMPUTER APPLICATIONS

Total Contact Hours		T	P	C
Theory:	32 Hrs	1	3	2
Practical:	96 Hrs			

Pre-requisites: None

AIMS: This subject will enable the student to be familiar with the basic daily life applications of computer. Trainee will also learn computer applications and other information according to profession at elementary level. Trainee will learn the knowledge and skills regarding EDP, Windows OS, MS-Word, C++, Spread Sheets (Excel), Power Point & Internet.

COURSE CONTENTS:

- 1. ELECTRONIC DATA PROCESSING (E.D.P.)** **4 Hours**
 - 1.1 Basic Terms of Computer Science Data & its, types, Information, Hardware, Software
 - 1.2 Computer & its types
 - 1.3 Generations of Computers
 - 1.4 Block diagram of a computer system
 - 1.5 BIT, Byte, RAM & ROM
 - 1.6 Input & Output devices
 - 1.7 Secondary storage devices
 - 1.8 Types of Software
 - 1.9 Programming Languages
 - 1.10 Applications of computer in different fields
 - 1.11 Applications in Engineering, Education & Business

- 2. MS-WINDOWS 2010** **6 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 Searching a document

- 3. MS-OFFICE (MS-WORD 2016)** **7 Hours**
 - 3.1 Introduction to MS-Office
 - 3.2 Introduction to MS-Word & its Screen
 - 3.3 Create a new document
 - 3.4 Editing & formatting the text
 - 3.5 Saving & Opening a document
 - 3.6 Page setup (Set the Margins & Paper)
 - 3.7 Spell Check & Grammar
 - 3.8 Paragraph Alignment
 - 3.9 Inserting Page numbers, Symbols, Text box & Picture in the document
 - 3.10 Use the different Format menu drop down commands(Drop Cap, Change Case, Bullet

- & Numbering and Border & Shading)
- 3.11 Insert the "Table and its Editing
- 3.12 Printing the document
- 3.13 Saving a document file as PDF format
- 4. MS-OFFICE (MS-EXCEL 2016) 4 Hours**
 - 4.1 Introduction to MS-Excel & its Screen
 - 4.2 Entering data & apply formulas in worksheet
 - 4.3 Editing & Formatting the Cells, Row & Column
 - 4.4 Insert Graphs in sheet
 - 4.5 Page setup, Print Preview & Printing
 - 4.6 Types & Categories of Charts
- 5. MS-OFFICE (MS-POWER POINT 2016) 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 & colors to a slide
 - 5.5 Making slide shows
 - 5.6 Slide Transition
- 6. INTRODUCTION TO PROGRAMMING 4 Hours**
 - 6.1 Introduction to computer programming and languages
 - 6.2 Introduction to C++
 - 6.3 Arithmetical operations
 - 6.4 Logical operations
 - 6.5 Looping
 - 6.6 Flow chart
- 7. INTERNET & E-MAIL 3 Hours**
 - 7.1 Introduction to Internet & browser window
 - 7.2 Searching, Saving and Print a page from internet
 - 7.3 Creating, Reading & Sending E-Mail
 - 7.4 File Attachment
 - 7.5 Uploading and downloading file(s) and software(s)
 - 7.6 Explain some advance features over the internet and search engines
 - 7.7 Difference between Internet, Intranet and Extranet

COMP-162 COMPUTER APPLICATIONS

INSTRUCTIONAL OBJECTIVES:

1. UNDERSTAND ELECTRONIC DATA PROCESSING (E.D.P)

- 1.1. Describe Basic Terms of Computer Science. Data & its Types, Information, Hardware, Software
- 1.2. Explain Computer & its types
- 1.3. Generations of Computers
- 1.4. Explain Block diagram of a computer system
- 1.5. State the terms such as BIT, Byte, RAM & ROM
- 1.6. Identify Input & Output devices
- 1.7. Describe Secondary Storage devices
- 1.8. Explain Types of Software
- 1.9. Introduction to Programming Language
- 1.10. Explain Applications of computer in different fields
- 1.11. Application in Engineering, Education & Business

2. UNDERSTAND MS-WINDOWS 2010

- 2.1 Explain Introduction to Windows
- 2.2 How to install Drivers & Windows
- 2.3 Describe Loading & Shut down process
- 2.4 Explain Introduction to Desktop items(Creation of Icons, Shortcut, Folder & modify Taskbar)
- 2.5 Explain Desktop properties
- 2.6 Describe Use' of Control Panel (add/remove program, time & date, mouse and create user account)
- 2.7 Explain the method of searching a document

3. UNDERSTAND MS-OFFICE (MS-WORD 2016)

- 3.1 Explain Introduction to MS-Office
- 3.2 Describe -Introduction to MS-Word & its Screen
- 3.3 Describe create a new document
- 3.4 Explain Editing & formatting the text
- 3.5 Describe saving & Opening a document
- 3.6 Explain Page setup, (Set the Margins & Paper)
- 3.7 Describe Spell Check & Grammar
- 3.8 Explain Paragraph Alignment
- 3.9 Explain Inserting Page numbers, Symbols, Text box & Picture in the document
- 3.10 Describe Use the different Format menu drop down commands(Drop Cap, Change Case, Bullet & Numbering and Border & Shading)
- 3.11 Explain Insert the Table and its Editing and modifying
- 3.12 Describe printing the document
- 3.13 Describe the method of file saving as a PDF Format

4. UNDERSTAND MS-OFFICE (MS-EXCEL 2016)

- 4.1 Explain Introduction to MS-Excel & its Screen

- 4.2 Describe Entering data & apply formulas in worksheet
- 4.3 Describe Editing & Formatting the, Cells, Row & Column
- 4.4 Explain Insert Graphs in sheet
- 4.5 Describe Page setup, Print preview & Printing
- 4.6 Explain in details formulas for sum, subtract, multiply, divide, average
- 4.7 Explain in details the types of charts e.g pie chart, bar chart

5. UNDERSTAND MS-OFFICE (MS-POWER POINT 2016)

- 5.1 Describe Introduction to MS-Power point
- 5.2 Explain creating a presentation
- 5.3 Describe Editing & formatting a text box
- 5.4 Explain Adding pictures & colors to a slide
- 5.5 Describe Making slide shows
- 5.6 Explain Slide Transitions

6. UNDERSTAND LANGUAGE

- 6.1 Define program, programming, programmer , and programming languages.
- 6.2 Classify computer programming languages.
- 6.3 Describe briefly computer languages.
- 6.4 Describe C++ programming language and its advantages.
- 6.5 Explain arithmetic operations (addition, multiplication, subtraction, division etc.)
- 6.6 Explain logical operations (AND, OR, NOT, Equal to, etc.)
- 6.7 Explain the basics of loops for repetitive operations.
- 6.8 Explain the components of Flow-Charts for simple computer program.

7. UNDERSTAND INTERNET & E-MAIL

- 7.1 Explain Introduction to Internet and browser window
- 7.2 Explain Introduction to Internet and browser window
- 7.3 Explain Searching, Saving and Print a page from internet
- 7.4 Describe Creating, Reading & Sending E-Mail
- 7.5 File attachment.
- 7.6 Uploading and downloading file(s) and software(s)
- 7.7 Explain some advance features over the internet and how to search topics on different search engines
- 7.8 Difference between Internet, Intranet and Extranet

COMP-162 COMPUTER APPLICATIONS

List of Practical:	96 Hours
1. Identify key board, mouse, CPU, disk drives, disks, monitor, and printer, Speakers, microphone, scanner, digital camera, card reader, DSL Modem and other magnetic elements.	3 Hours
2. MS WINDOWS 2010	18 Hours
2.1 Practice of loading and shutdown of operating system	
2.2 How to install Drivers & Windows	
2.3 Creating items (icons, shortcut, folders etc) and modifying taskbar	
2.4 Changing of wallpaper, screensaver, and resolution	
2.5 Practice of control panel items (add/remove, time and date, mouse, and create user account)	
3. MS OFFICE (MS-WORD 2016)	27 Hours
3.1 Identifying the MS Word Screen and its menu	
3.2 Practice of create a new document, saving and re-opening it from the location and spell check & grammar	
3.3 Practice of Page Formatting (Borders, Character Spacing, Paragraph, Bullets & Numberings and Fonts)	
3.4 Practice of different tool bars like standard, format& drawing tool bars	
3.5 Practice of Insert pictures, clipart, and shapes	
3.6 Practice of header and footer	
3.7 Practice of insert table and also format of table	
3.8 Practice of page setup, set the page margins, and printing documents	
4. MS OFFICE (MS-EXCEL 2016)	18 Hours
4.1 Identifying the MS EXCEL Screen and its menu	
4.2 Practice of create a new sheet, saving and re-opening it from the location and spell check	
4.3 Practice of insert and delete of row and columns (format of cell)	
4.4 Practice of entering data and formulas in worksheet(Add, Subtract, Multiplying, and Divide & Average)	
4.5 Repeating practical serial number04	
4.6 Practice of insert chart and its types	
4.7 Practice of page setup, set the page margins, and printing	
5. MS OFFICE (MS-POWER POINT 2016)	09 Hours
5.1 Identifying the MS POWER POINT Screen and its menu	
5.2 Practice of create a new presentation and save	
5.3 Practice of open saves presentations	
5.4 Practice of inset picture and videos	
6. INTRODUCTION TO PROGRAMMING LANGUAGE	12 Hours

- 6.1 Practice on C++ for addition, multiplication, subtraction, division etc.
- 6.2 Practice on C++ using loop statements.
- 6.3 Practice on C++ using logical operations (AND, OR, NOT, Shift, Equal to etc)
- 6.4 Practice on C++ using incremental statement.
- 6.5 Practice of making flow chart(Prepare a flow chart to find the sum of 529 and 256)

7. INTERNET & E-MAIL

09 Hours

- 7.1 Identifying internet explorer
- 7.2 Practice of searching data from any search engine
- 7.3 Practice of create an E-Mail account and how to send and receive mails, download attachments
- 7.4 File attachment.
- 7.5 Uploading and downloading file(s) and software(s)

COMP-162 COMPUTER APPLICATIONS PRACTICAL OBJECTIVES:

- 1. Identify key board, mouse, CPU, disk drives, disks, monitor, and printer**
 - Understand use and features of keyboard, CPU, disk drives, disks, monitor, and printer

- 2. MS WINDOWS 2010**
 - 2.1 Practice of loading and shutdown of operating system**
 - Students will be able to load and shutdown of operating system (MS Windows 2010)
 - Students will be able to Install the operating system(MS Windows 2010) & its Drivers
 - 2.2 Creating items (icons, shortcut, folders etc) and modifying taskbar**
 - Student will be able to create, modify & delete icons, shortcuts, & folders in MS Windows 2010
 - 2.3 Changing of wallpaper, screensaver, and resolution**
 - Student will be able to change wallpapers, screensavers, & resolution size in MS Windows 2010
 - 2.4 Practice of control panel items (add/remove, time and date, mouse, and create user account)**
 - Student will be able to adjust control panel items (add/remove, time & date, Mouse, and configure the user account) in MS Windows 2010

- 3. MS OFFICE (MS-WORD 2016)**
 - 3.1 Identifying the MS Word Screen and its menu**
 - Student will be able to identify the MS Word screen and its menus in MS Word 2016
 - 3.2 Practice of create a new document, saving and re-opening it from the location and spell check & grammar**
 - Student will be able to create new documents, save documents and reopen the saved documents and spell check and grammar
 - 3.3 Practice of Page Formatting (Borders, Character Spacing, Paragraph, Bullets & Numberings and Fonts)**
 - Student will be able to change the format of documents (Borders, Character Spacing, Paragraph, Bullets & Numberings and Fonts)
 - 3.4 Practice of different tool bars like standard, format & drawing tool bars**
 - Student will be able to use the standard, format and drawing tools
 - 3.5 Practice of Insert pictures, clipart, and shapes**
 - Student will be able to add pictures, clipart and different shapes into document in MS Word 2016
 - 3.6 Practice of header and footer**
 - Student will be able to make and adjust header & footer in MS Word 2016
 - 3.7 Practice of insert table and also format of table**
 - Student will be able to insert and format the table in MS Word 2016
 - 3.8 Practice of page setup, set the page margins, and printing documents**
 - Student will be able to adjust page setup, margin and print documents in MS Word 2016

- 4. MS OFFICE (MS-EXCEL 2016)**
 - 4.1 Identifying the MS EXCEL Screen and its menu**

- Student will be able to identify the MS EXCEL screen and its menus
- 4.2 Practice of creating a new sheet, saving and re-opening it from the location and spell check**
 - Student will be able to create new documents, save documents and reopen the saved documents and spell check and grammar
- 4.3 Practice of insert and delete of row and columns (format of cell)**
 - Student will be able to insert and delete row and columns
- 4.4 Practice of entering data and formulas in worksheet(Add, Subtract, Multiplying, and Divide & Average)**
 - Student will be able to use different formulas in worksheet(Add, Subtract, Multiplying, and Divide & Average)
- 4.5 Repeating practical serial number04**
- 4.6 Practice of insert chart and its types**
 - Student will be able to insert different types of chart into worksheet
- 4.7 Practice of page setup, set the page margins, and printing**
 - Student will be able to adjust page setup, margin and print worksheets

5. MS OFFICE (MS-POWER POINT 2016)

- 5.1 Identifying the MS POWER POINT Screen and its menu**
 - Student will be able to identify the MS POWER POINT screen and its components.
- 5.2 Practice of create a new presentation and save**
 - Student will be able to create a presentation and save it
- 5.3 Practice of open saves presentations**
 - Student will be able to open the saves presentations
- 5.4 Practice of inset picture and videos**
 - Students will be able to insert picture and video clips

6. PROGRAMMING LANGUAGE

6.1 Practice on C++ for addition, multiplication, subtraction, division etc.

By the end of this practical, Students will be able to

- Add two numbers using C++ program
- Subtract one value from other value using C++ program
- Multiplies two values using C++ program
- Divide one value by another value using C++ program

6.2 Practice on C++ using loop statements.

By the end of this practical, Students will be able to

- Student will be able to use Loop constructs (for-Loop, While-Loop, do-while Loop).

6.3 Practice on C++ using logical operations (AND, OR, NOT, Shift, Equal to etc).

By the end of this practical, Students will be able to

- Use logical operators (AND, OR, NOT, Shift, Equal to etc).

6.4 Practice on C++ using incremental statement.

By the end of this practical, Students will be able to

- Student will be able to program increment (*postfix & prefix*) and decrement (*postfix & prefix*)operator

7. INTERNET & E-MAIL

7.1 Recognize MS Edge Browser screen

- Students will be able to identify the components of MS Edge browser screen and their function.

7.2 Practice of searching data from any search engine

- Students will be able to search information catalog, e-books etc from different search engine

7.3 Practice of creating an E-Mail account, send and receive E-mails and download attachments

- By the end of this practical, students will be able to
- Create a new E-mail account.
 - Send and receive e-mails.
 - download & upload files and attachments

RECOMMENDED BOOKS:

1. Bible Microsoft Office 2016 by John Walkenbach
2. Let us C++ by yashwant kanetkar
3. Bible Microsoft Excel 2016 by John Walkenbach
4. Bible Microsoft PowerPoint 2016 by John Walkenbach
5. C++ how to program by deitel & deitel
6. User Guides for Windows 2010 and MS Office 2016 by Microsoft Corporation

ET 125 PRINCIPLES OF ELECTRICAL ENGINEERING

Total Contact Hours:		T	P	C
Theory:	96	3	6	5
Practicals:	192			

AIMS Understanding electricity involves the sound familiarity with the established laws and concepts, and their application in different situations. Thus solving problems also forms part of the cognition of these concepts.

This course aims at providing a strong foundation in these basic concepts and laws of electricity, alongwith an appreciation of the magnitudes of the quantities involved or to be guessed, through solving numerical problems. The concepts are further strengthened through extensive Laboratory work.

COURSE CONTENTS

UNIT-I D.C. FUNDAMENTAL

- 1. BASIC CONCEPTS OF ELECTRICITY (15 Hrs.)**
 - 1.1 Electron theory.
 - 1.2 Electric Charge, Electric Current, Potential Difference, Resistance, Conductance.
 - 1.3 Conductor, Insulator, Semiconductor.
 - 1.4 Ohm's Law.
 - 1.5 Laws of resistance
 - 1.6 Effect of temperature on resistance.
 - 1.7 Temperature coefficient of resistance.
 - 1.8 Series and parallel circuits
 - 1.9 Resistances in series and parallel.
 - 1.10 Division of voltage in series circuit.
 - 1.11 Division of current in parallel circuit.
 - 1.12 Resistances in combination circuits.

- 2. NETWORK THEOREMS (5 Hrs.)**
 - 2.1 Active & passive circuits, node, branch, mesh and loop in Electrical circuits.
 - 2.2 Kirchhoff's law I - current law.
 - 2.3 Kirchhoff's law II-voltage law.
 - 2.4 Application of Kirchhoff's laws.
 - 2.5 Problem solving with Kirchhoff's Laws in D.C. circuit. (Simple problems)
 - 2.6 Superposition theorem.
 - 2.7 Maximum power transfer theorem.
 - 2.8 Thevenin's theorem.

- 3. WORK, POWER AND ENERGY (8 Hrs.)**
 - 3.1 Work, Power and Energy

- 3.2 Conversion of electrical power into mechanical power.
- 3.3 Energy billing.
- 3.4 Heating effect of current.
- 3.5 Joule's Law.
- 3.6 Thermal efficiency.

4. ELECTROMAGNETISM (9 Hrs.)

- 4.1 Magnet and magnetism.
- 4.2 Basic concepts and terminology of magnetism.
- 4.3 Absolute and relative permeability.
- 4.4 Magnetic hysteresis
- 4.5 Laws of magnetic force.
- 4.6 Magnetic field due to a straight current carrying conductor.
- 4.7 Right hand thumb rule, Cork-Screw rule.
- 4.8 Magnetic field of coil
- 4.9 Right hand gripping rule, End rule
- 4.10 Effect of iron core in a coil.
- 4.11 Mechanical force on a current carrying conductor in a magnetic field.
- 4.12 Fleming's right hand and left hand rules.

5. ELECTROMAGNETIC INDUCTION (3 Hrs.)

- 5.1 Faraday's Laws of electromagnetic induction.
- 5.2 Dynamically and statically induced EMF.
- 5.3 Lenz's Law.
- 5.4 Self and Mutual induction.
- 5.5 Eddy current.

6. ELECTROSTATICS (8 Hrs.)

- 6.1 Static Electricity.
- 6.2 Basic concepts and terminology of Electrostatics.
- 6.3 Absolute and relative permeability of a medium.
- 6.4 Laws of Electrostatics.
- 6.5 Capacitor and its types.
- 6.6 Capacitance
- 6.7 Capacitors in series and parallel.
- 6.8 Charging of a capacitor and its equation.
- 6.9 Discharging of a capacitor and its equation.

UNIT-II A.C FUNDAMENTALS

7. FUNDAMENTALS OF A.C (10 Hrs.)

- 7.1 Alternating current & voltage.
- 7.2 Working principle of Alternating current generator.
- 7.3 Simple loop Alternator, Relationship between Speed, poles and frequency.
- 7.4 Sinusoidal EMF Equation.
- 7.5 Wave forms and types

- 7.6 Cycle, Time Period, Frequency, Maximum (Peak) value, Peak to Peak value, Instantaneous value, Average value, R.M.S value (Effective value), Form factor, Peak factor.
- 7.7 Representation of A.C. through vectors.
- 7.8 Phase, Phase difference, In-phase, Out of Phase, Phase Quadrature, Anti-phase, Lagging & Leading.
- 7.9 Phasor Diagrams.
- 7.10 Complex Numbers.
- 7.11 Rectangular and Polar form conversion

8. SINGLE PHASE A.C. CIRCUIT (20 Hrs.)

- 8.1 A.C through pure Resistance and Vector Diagram.
- 8.2 A.C through pure Inductance and Vector Diagram.
- 8.3 A.C through pure Capacitance and Vector Diagram.
- 8.4 A.C through pure Resistance & Inductance in series, including wave forms and Phasor diagram.
- 8.5 A.C through Resistance and Capacitance connected in series including wave forms and phaser diagram.
- 8.6 Voltage, current and power relation in A.C. R-L and R-C Circuits.
- 8.7 R.L.C series circuit.
- 8.8 Impedance Triangle, Phase angle.
- 8.9 Active and Reactive component. Actual power, Apparent Power, Reactive Power, relationship, Power triangle, Power factor.
- 8.10 Parallel A.C circuits.
- 8.11 Solution of Parallel circuits by vector and admittance method.
- 8.12 Solution of simple problems with Phasor Algebra.
- 8.13 Power factor improvement with static capacitor.
- 8.14 Resonance circuit.
- 8.15 Series, parallel resonance circuit.
- 8.16 Problems on resonant circuits.
- 8.17 Harmonics, True Power Factor

UNIT-III POLY-PHASE FUNDAMENTALS

9. POLY-PHASE A.C. CIRCUIT (18 Hrs.)

- 9.1 Generation of two phase, three Phase EMF.
- 9.2 Advantages of Poly Phase system.
- 9.3 Star & Delta connections.
- 9.4 Relationship between line and phase values of star & delta connections.
- 9.5 Comparison of Star and Delta connections, their uses, and conversion.
- 9.6 Power in a three phase balanced load.
- 9.7 Vector diagram of Star and Delta connected load.
- 9.8 Current in Neutral in a 3 Phase circuit.
- 9.9 Problem solving on star and delta connections.
- 9.10 Measurement of power with one watt meter without the use of Neutral wire.
- 9.11 Measurement of power with two watt meters and its vector diagram.
- 9.12 Measurement of Power with three watt meters and its vector diagram.

- 9.13 Measurement of Reactive power in a three phase circuit.
- 9.14 Calculation of P.F. with Active and reactive power.
- 9.15 Phase sequence.
- 9.16 Advantages of 3 Phase supply over single Phase supply.
- 9.17 Problem solving on 3 Phase circuits.

ET- 125 PRINCIPLES OF ELECTRICAL ENGINEERING

INSTRUCTIONAL OBJECTIVES

UNIT-I: D.C. FUNDAMENTALS

1. UNDERSTAND BASIC CONCEPTS OF ELECTRICITY

- 1.1 State Electron theory.
- 1.2 Define Electric Charge, Electric Current, Potential Difference, Resistance, Conductance and state their units
- 1.3 Define and compare Conductor, Insulator & Semi-conductor.
- 1.4 State Ohm`s law and calculations.
- 1.5 Explain laws of resistance and calculations.
- 1.6 State effects of temperature on Resistance.
- 1.7 Calculate temperature co-efficient of Resistance.
- 1.8 Define series and parallel circuits of resistances with their properties.
- 1.9 Determine total resistances in series & parallel circuits.
- 1.10 Calculate division of voltage in series circuits.
- 1.11 Calculate division of current in parallel circuits.
- 1.12 Draw equivalent circuits for combination of resistances, calculate equivalent resistance.

2. UNDERSTAND KIRCHHOFF'S LAWS

- 2.1 Define active circuit, passive circuit, node, branch, mesh & loop.
- 2.2 State Kirchhoff`s 1st Law - (current Law).
- 2.3 State Kirchhoff`s 2nd Law - (voltage Law).
- 2.4 Give examples for applications of Kirchhoff's Laws.
- 2.5 Solve simple problems on Kirchhoff's Laws in D.C circuits.
- 2.6 State superposition theorem.
- 2.7 State maximum power transfer theorem.
- 2.8 State Thevenin's Theorem.

3. UNDERSTAND WORK, POWER & ENERGY

- 3.1 Define work, electrical power, mechanical power and energy with their units. Calculations on Power and Energy
- 3.2 State formula for conversion of Electrical Power (Watt) to Mechanical Power (H.P).
- 3.3 Calculate Energy billing of an installation.
- 3.4 Explain heating effect of current.
- 3.5 State Joule's Law of current.
- 3.6 Define thermal efficiency. Solve problems on Thermal Efficiency.

4. UNDERSTAND MAGNETIC EFFECTS OF ELECTRIC CURRENT

- 4.1 Define magnet and magnetism, types of magnet with properties.
- 4.2 Define Magnetic field, Define Magnetic lines of force and properties, Define Magnetic flux and state unit, Define Magnetic flux density and state unit, Define Magneto-motive force and state unit, Define Reluctance and Permeance, Define Magnetic field strength (magnetizing force) and Retentivity, Define Magnetic circuit, Compare magnetic circuit with electric circuit.
- 4.3 Define Absolute & Relative permeability.
- 4.4 Define magnetic hysteresis, state magnetization curve (B – H curve).
- 4.5 Explain Laws of Magnetic force.
- 4.6 Describe Magnetic field of a straight current carrying conductor.
- 4.7 State right hand thumb rule, State cork-screw rule.
- 4.8 Determine Magnetic field of a coil.
- 4.9 State Right hand gripping rule, State End rule
- 4.10 Describe effect of iron core in a coil.
- 4.11 Explain mechanical force on a current carrying conductor in a magnetic field.
- 4.12 State Fleming's Right hand & Left hand rules.

5. UNDERSTAND ELECTROMAGNETIC INDUCTION

- 5.1 State Faraday's Laws of Electromagnetic Induction.
- 5.2 State dynamically & statically induced EMF.
- 5.3 Explain Lenz's Law
- 5.4 State self & mutual inductance. State unit of inductance.
- 5.5 State Eddy current.

6. UNDERSTAND FUNDAMENTALS OF ELECTROSTATICS

- 6.1 Define static-electricity(Electrostatics).
- 6.2 Define Electric field, Define Electric lines of force and properties, Define Electric flux, Electric flux density, Electric field strength
- 6.3 Describe Absolute & Relative Permeability of a Medium.
- 6.4 State Laws of Electrostatics.
- 6.6 State the term capacitance and state its unit.
- 6.5 Define capacitor, list types of capacitors.
- 6.7 Define series and parallel circuits of capacitors with their properties, Solve problems on capacitors in series & parallel.
- 6.8 Explain charging of capacitor along with equation.
- 6.9 Explain discharging of capacitor along with equation.

UNIT-II: A.C. FUNDAMENTALS

7. UNDERSTAND A.C. FUNDAMENTALS

- 7.1 Define alternating current & voltage.
- 7.2 Describe principle of working of A.C. Generator.
- 7.3 Explain simple loop Alternator & relationship between speed, poles and frequency.
- 7.4 State sinusoidal E.M.F. equation.
- 7.5 Define Wave form, State types; Sinusoidal wave form and non-sinusoidal wave forms; square, triangular, saw-tooth.

- 7.6 Define terms Cycle, Time Period, Frequency, Maximum (Peak) value, Peak to Peak value, Instantaneous value, Average value, R.M.S value (Effective value), Form factor, Peak factor, Phase, Phase difference, In-phase, Out of Phase, Phase Quadrature, Lagging & Leading waves.
- 7.7 Explain how AC quantities can be represented by vectors.
- 7.8 Define the terms according to wave form and vectors; Phase, Phase difference, In-phase, Out of Phase, Phase Quadrature, Anti-phase, Lagging & Leading.
- 7.9 Draw phasor diagrams.
- 7.10 Define Complex number, describe rectangular form and polar form of A.C quantities.
- 7.11 Conversion from R-P form and P-R form, simple calculations.

8. UNDERSTAND A.C. CIRCUITS (SINGLE PHASE)

- 8.1 Explain the effects of A.C. supply through pure resistance, inductance & Capacitance with their waveforms, vector diagrams and power curves.
- 8.2 Describe the effects of A.C. supply through RL and RC Series circuits with the help of waveforms and vector diagrams.
- 8.3 Derive voltage current & power relation in A.C. circuits.
- 8.4 Explain R.L.C series circuit and Solve examples on R.L.C. series circuit.
- 8.5 Define terms impedance, impedance triangle. Draw impedance triangle of A.C Circuits, phase angle.
- 8.6 Describe active & reactive component, actual power, apparent power & reactive power with relationships, Define Power factor
- 8.7 Explain parallel A.C circuits (R.L.C).
- 8.8 Solve problems on parallel A.C. circuits
- 8.9 Explain power factors improvement with static capacitor bank.
- 8.10 Write relationship for V.I.Z. for resonance circuit in series & parallel.
- 8.11 Solve simple problem on resonance circuits.
- 8.12 State harmonics.
- 8.13 Concept of True power factor

UNIT-III: POLYPHASE FUNDAMENTALS.

9. UNDERSTAND POLYPHASE A.C. CIRCUITS

- 9.1 Explain generation of two-phase & 3-phase e.m.f.
- 9.2 Explain advantages of A.C. polyphase system.
- 9.3 Draw & explain star & delta connections.
- 9.4 Calculate relationship between line & phase values in star & delta.
- 9.5 Compare star & delta connections with their uses.
- 9.6 State power equation for 3-phase system.
- 9.7 Draw vector diagrams of star & delta connected loads.
- 9.8 State value of current in neutral in a 3-phase balanced circuit.
- 9.9 Solve problems on star and delta connected 3-phase balanced load.
- 9.10 Explain Measurements of power with one wattmeter without the use of neutral wire.
- 9.11 Describe Measurement of power with two watt meters along with its vector diagram.
- 9.12 Calculate power with three watt-meters along with vector diagrams.

- 9.13 Describe Measurement of Reactive power in a three phase circuit.
- 9.14 Solve problems on P.F with active & reactive power.
- 9.15 Define phase sequence, Explain phase sequence meter.
- 9.16 Explain advantages of 3-phase supply over single phase supply.
- 9.17 Solve problems on 3-phase circuits.(Balanced load)

ET- 125 PRINCIPLES OF ELECTRICAL ENGINEERING

LIST OF PRACTICALS

Note: Students should demonstrate concern for personal and equipment safety while working in Electrical Labs

1. Study of simple Electrical Instruments (Ammeter, Voltmeter etc.)
2. Determination of the resistances of
 - a) Sliding Rheostat.
 - b) Voltmeter.
 - c) Incandescent lamp.
3. Determination of resistance of a wire by micrometer.
4. Determination of temperature co-efficient of copper by ammeter-voltmeter methods.
5. Verification of Ohm's law.
6. Verification of laws of combination of resistances.
7. Study of various types of resistors and determination of resistance by color coding.
8. Measurement of power by voltmeter-ammeter method and watt meter.
9. Study of connections of thermal relay.
10. Measurement of energy by energy meter.
11. Verification of Kirchhoff's Laws.
12. Determination of the efficiency of an electric Kettle.
13. Make an electromagnet.
14. Study of the force on a current-carrying conductor in magnetic field.
15. Verification of Faraday's laws of electromagnet induction.
16. Study of Generator and Transformer.
17. Study the production of e.m.f in coupled coils by changing current in one coil.
18. Problem solving session.
19. Study of self-induction of a coil and effect of introducing iron core in it.
20. Study of various types of capacitors and inductors.
21. Determination of the capacity of capacitors by colour coding.
22. Verification of the laws of the combination of capacitors.
23. Determination of breakdown voltage of a low-voltage capacitor.
24. Test week: Every student should be given independent different practicals and teacher should count its performance towards sessional marks.
25. Study of C.R.O/ DSO and measurement of sine wave.
26. Determination of average and R.M.S values and sine wave (on graph paper)
27. Determination of inductance of a choke coil using ammeter and voltmeter method.
28. Determination of impedance of a resistive-inductive series circuit.
29. Study of phase displacement by C.R.O/ DSO.
30. Determination of power consumed by a fan/choke by 3-ammeter method.
31. Vector Diagrams practice.
32. Determination of power-factor of a single phase circuit using voltmeter, ammeter and watt meter.
33. Measurement of power factor of a single phase circuit using a power factor meter.

34. Determination of resonance frequency of a series circuit using variable frequency oscillator.
35. Study of the effects of capacitors on the power of an inductive circuit.
36. Study of an elementary poly phase generator.
37. Verification of the line and phase relationship in star and delta connections.
38. Study of 3-Phase, 4-wire distribution network.
39. Measurement of power of a 3-phase load by 3-wattmeter method.
40. Measurement of power of a 3-phase load by 2-wattmeter method.
41. Measurement of 3-phase power by one watt meter method.
42. Determination of phase sequence by phase sequence meter.
43. Measurement of reactive power in a 3-phase balanced circuit.
44. Measurement of power in 3 phase circuit using phase angle meter.
45. Measurements of 3-Phase load energy using C.T. & P.T.
46. Improvement of power factor of an inductive load using capacitors and its verification.
47. Determination of current in neutral wire in balanced & unbalanced load.

Each student must conduct one practical for evaluation for final test.

** Students must prepare theory and practical note books and get it checked weekly by the concerned teacher. He should produce it to external examiner for sessional work/marking check up at the time of final exam.

Books Recommended:

1. New Electric Library Vol III by Frank Graham.
2. Electrical Engineering by C.L Dawes.
3. Examples of Electrical Calculation Admiralty.
4. Electrical Technology by B.L Teraja.
5. Reeds Basic Electro-Technology for Marine Engineers by E.G. Krall.
6. Fundamentals of Electrical Engineering by M.Kuzmetsov Moscow.
7. Theory & Problems of Electrical Circuit by Schaum's out line series.
8. Electrical Technology by Edward Huges.
9. Practical Electricity by T.Croft.
10. Industrial Electric Circuits by Herbart W.Jackson.

ET-131 BASIC ELECTRICAL DRAWING

	T	P	C
Total Contact Hours	0	3	1
<i>Practical</i> 96 Hrs.			

AIM To provide basic skills in the use of drawing tools and to enable the students to prepare Orthographic, pictorial, free hand sketching for electrical drawings

COURSE CONTENTS

(SHOP TALK ONLY)

1. USES AND APPLICATION OF TECHNICAL DRAWING

- 1.1 Importance of Technical drawing and Techniques.
- 1.2 Uses of technical drawing, tools and equipments.
- 1.3 Types of electrical drawings.

2. DRAWING TOOLS AND MATERIALS

- 2.1 Classification of drawing pencils and uses
- 2.2 Types of drawing papers and sizes
- 2.3 Drawing instruments and uses.
- 2.4 Types and use of erasers.
- 2.5 Care & maintenance of drawing tools.

3. BASIC DIMENSIONING

- 3.1 Definition of dimensioning.
- 3.2 Two types of dimensioning.
- 3.3 Elements in dimensioning.
- 3.4 Dimensioning pictorials.
- 3.5 Dimensioning Multi Views.
- 3.6 Dimensioning Holes and arcs.
- 3.7 Dimensioning Angles.

4. MULTI VIEW DRAWING/ORTHOGRAPHIC DRAWING

- 4.1 Definition and concept.
- 4.2 Six principle views.
- 4.3 Visualization glass box technique.
- 4.4 Principal planes of projections.
- 4.5 Projection lines.
- 4.6 Arrangement of views.
- 4.7 Multi view drawing, 1st angle and 3rd angle projection of simple objects.

5. INTRODUCTION TO PICTORIAL DRAWING

- 5.1 Three types of pictorials
- 5.2 Uses of pictorial views.
- 5.3 Isometric sketching of Rectangular Block and simple objects.

- 5.4 Oblique sketching of rectangular block and simple objects.
- 5.5 Proportions in pictorial drawing.

6. SYMBOLS

- 6.1 Building Material symbols.
- 6.2 Metal symbols.
- 6.3 Electrical symbols.
- 6.4 Importance and uses.

7. ELECTRICAL DRAWING

- 7.1 Drawing wiring circuits.
 - 7.1.1 Single line diagram.
 - 7.1.2 Wiring diagram.
 - 7.1.3 Layout diagram.
 - 7.1.4 Schematic diagram.
 - 7.1.5 Circuit diagram.

8. LINE SKETCHING

- 8.1 Introduction to sketching techniques.
- 8.2 Sketching Horizontal, vertical, inclined lines.
- 8.3 Sketching of parallel (Horizontal, vertical, inclined lines).
- 8.4 Sketching arcs and circles.
- 8.5 Sketching squares, Rectangles, ellipses and simple objects.
- 8.6 Proportion in sketching.

RECOMMENDED BOOKS

- 1. Interior Electrical Wiring & Estimating (Residential) by Uhl-Dunlap-Flynn.
- 2. Interior Electrical Wiring & Estimating by Graham.
- 3. How to Read Electrical Blue Prints by Heine-Dunlap.
- 4. Power Wiring by Audels.
- 5. Elementary Engineering Drawing by N.D.Bhat.
- 6. Elementary Engineering Drawing by A.T. Parkinson.

ET-131 BASIC ELECTRICAL DRAWING

INSTRUCTIONAL OBJECTIVES

- 1. A. UNDERSTAND THE IMPORTANCE OF TECHNICAL DRAWING AND
 CONSTRUCT GEOMETRICAL SHAPES.**
**B. APPRECIATE THE POWER OF DRAWING AS A TOOL OF
 COMMUNICATING IDEAS.**
 - 1.1 Define importance of technical drawing.
 - 1.2 Use drawing equipment, board, sheet, pencil, T-square, set square, compass, divider, protractor, French curves etc.
 - 1.3 Draw different types of lines.
 - 1.4 Show skill in lettering and dimension
 - 1.5 Divide a line in two and more than two parts.
 - 1.6 Draw different angles and bisect.
 - 1.7 Draw square, rectangle, triangles, circle, hexagon, ellipses.

- 2. UNDERSTAND ORTHOGRAPHIC DRAWING/MULTI-VIEW DRAWING AND
 PICTORIAL DRAWING**
 - 2.1 Prepare 1st angle drawings.
 - 2.2 Prepare drawings according to 3rd angle projection.
 - 2.3 Draw surface development of simple objects.
 - 2.4 Draw oblique and pictorial view of simple shapes and objects.

- 3. UNDERSTAND ELECTRICAL SYMBOLS, RESIDENTIAL, AND POWER WIRING,
 AND DIFFERENT POWER CIRCUITS/DRAWINGS**
 - 3.1 Draw electrical symbols.
 - 3.2 Describe types of electrical drawings (Block diagram, Circuit diagram, Line diagram, Wiring Diagram).
 - 3.3 Draw single phase wiring circuits.
 - 3.4 Draw wiring circuit diagram of house wiring along with point position of single room and double room houses on given building layouts.
 - 3.5 Draw wiring diagrams of motors.
 - 3.6 Draw different industrial wiring circuits.
 - 3.7 Draw three phase wiring circuits layout.

- 4. SHOW SKILL IN FREE HAND SKETCHING**
 - 4.1 Sketch free hand horizontal, vertical, and inclined lines.
 - 4.2 Sketch free hand rectangles, triangles, circles, arcs, ellipse.
 - 4.3 Sketch free hand, oblique and isometric views of simple regular objects.

ET-131 BASIC ELECTRICAL DRAWING

LIST OF PRACTICALS

1. Prepare the title block.
2. Draw the different lines according to rules (Horizontal and vertical lines) etc.
3. Draw square, rectangle, triangles, circle, hexagon, ellipse (at least 3 sheets).
4. Practice of lettering and dimensioning.
5. Draw first and third angle drawing of single parts, i.e. prism, stepped block, V-block, gland etc. (at least 5 sheets).
6. Draw isometric projection and oblique projection of rectangular prism, stepped block, v-block, angle block etc. (at least 5 sheets).
7. Draw the surface development of prism, cylinder, cone, square, pyramid (at least 3 sheets).
8. Draw the section diagram of a bolt and nuts.
9. Draw building materials, metals and electrical symbols (3 sheets).
10. Draw the single line diagram of 132KV/11KV grid-substation.
11. Draw layout diagram of a three bed room house showing positions of doors and their opening, windows and ventilators etc.
12. Draw the wiring layout diagram of house for practical No 11 with location of points.
13. Wiring diagram of a single phase motor with starter.
14. Circuit diagram of 3-phase motor with magnetic contractor and star delta starters.
15. Draw layout of earthing for a simple house (Earth Wire, Earth lead, Earthing Electrode).
16. Draw layout of earthing circuit for a shop or a factory.
17. Draw Single line power wiring diagram of a shop of a factory.
18. Draw single line power wiring of power lab of a technical college.
19. Draw schematic diagram of power control panel of power lab of a technical college.
20. Make drawing of supply distribution of a multi storey house.
21. Detailed drawing of a small house with front elevation.
22. Draw circuit diagram of six lines intercom-network.
23. Sketch free hand horizontal lines, vertical and inclined lines, rectangle, triangle, circle & ellipse (at least 2 sheets).
24. Sketch simple objects i.e. try square, switch plate, bulb holder, etc.
25. Sketch isometric view of a commutator.
26. Sketch sectional view of cable, single core cable, 3 core cable.
27. Sketch electrical tower.
28. Sketch insulators.
29. Draw a commutator.
30. Draw schematic diagram of a power supply/power house.

Note:- Students should prepare at least twenty drawings in college and thirty as home assignment. They should get it checked weekly by the concerned teacher. They should also produce all these drawings to the external examiner for marking/sectional work checkup at the time of final examination.

ET-143 WORKSHOP PRACTICE-I (ELECTRICAL)

Total Contact Hours:

T	P	C
1	6	3

Theory: 32
Practical: 192

AIM The course is aimed at providing skill in the use of tools and machines of common usage, to enable the student to develop simple projects related to wiring. Related safety concerns while working on the job, forms an integrated part of the course. Necessary information about the types, materials, tools/machines may be provided as shop-talk. For wiring, separate theory classes will provide the essential background knowledge of electrical rules and regulations.

1 ELECTRICAL WIRING 12 Hours.

1.1 HOUSE WIRING.

1.1.1 Wiring Cables:

- i. Terms related to cables (cable, Wire, Core, Armouring, Conductor, Insulation, Sheath etc.)
- ii. Types, systems and sizes of wiring cables and their current carrying capacity
- iii. Flexible cables and cords.
- iv. L.T and H.T power cables., Special purpose cables (heat resistant, fire resistant/proof and fire retarding, welding cable etc).
- v. Selection of electrical cables for a particular application
- vi. Voltage drops in cables and simple calculation.
- vii. Cable jointing

1.1.2 Electrical Wiring accessories and their ratings.

1.1.3 Domestic Wiring systems (PVC conduit and PVC channel/duct wiring)

1.1.4 Protection of house wiring.

- i. Fuses and circuit breakers.
- ii. Earthing.

1.1.5 Distribution of supply and distribution boxes. (Single and three phase)

1.1.6 Testing of wiring.

1.1.7 Electricity rules about domestic wiring and earthing.

1.2 INDUSTRIAL AND COMMERCIAL WIRING. 5 Hours.

1.2.1 Power wiring systems (Steel conduit, Trunking, Ducting, Centenary, Overhead bus bar, cable tray and Tough sheathed cable system)

1.2.2 Single & three phase supply for multi storey buildings.

1.2.3 Power wiring for motors, Cable and fuse / circuit breaker size for motor.

1.2.4 Study and use of magnetic contactors, push buttons, thermal overload relay and EOR(electronic over current relay).

2 ELECTRICITY RULES AND REGULATIONS.

2.1 Pakistan electricity rules 1973. 5 Hours.

2.1.1 Condition of supply by license (rule no. 25, 28, 29, 32, 40, 46).

2.1.2 General precaution for safety of public (Rule 49,51,52,57,58).

- 2.1.3 Electrical supply line and apparatus (Rule 60, 61, 62, 64).
- 2.2 I.E.E Regulation for Building installation. 5 Hours.**
(Institute of Electrical Engineers, London).
- 2.2.1 (Section-A).
Regulation No. and its brief description.
- A-1 Control of supply to consumer's Installation.
A-3 Excess current protection.
A-26 Final Sub-circuits of rating exceeding 15 A
- 2.2.2 Section B.
B-4 Type of flexible cables and flexible cords.
B-12 Choice of types of insulation and protective covering of flexible conductor sizes.
- 2.2.3 Section C
C-4 Selection for situation.
C-6 Damp situation.
- 2.2.4 Section D
D-1 Methods of protection.
D-22 Protection by fuse and current circuit Breaker for excess current.

3. FIRE PROTECTION AND SAFETY 5 Hours.

- 3.1 Fire
- 3.1.1 Fire
3.1.2 Classes of fire.
3.1.3 Causes of fire and its prevention,
- 3.2 Safety from electricity.
- 3.2.1 Safety in electrical shops (Safety Belt, Gloves, clothing and shoes).
3.2.2 General safety precaution (Machine Guards, tools & ladders).
3.3.3 Electric shock its prevention and treatment.

INSTRUCTIONAL OBJECTIVES

HOUSE WIRING

1. **UNDERSTAND ABOUT THE TYPES & SIZES OF ELECTRIC CABLES USED IN DOMESTIC WIRING.**
 - 1.1 Define cable, Wire, Core, Conductor, Insulation, Sheath and Armouring
 - 1.2 Name types of electrical cable (Wiring, power and control cables)
 - 1.3 Classify Wiring Cables with respect to insulation, core, voltage grade & strands of conductor etc.
 - 1.4 Define and distinguish between flexible cables and cords.
 - 1.5 Describe types of flexible cords.
 - 1.6 Define H.T and L.T power cables, Distinguish between L.T and H.T power cables; describe construction and applications of L.T and H.T Power cables
 - 1.7 Define special cables and describe construction and application of special purpose cables (heat resistant, fire resistant/proof fire retarding and welding cables)
 - 1.8 Explain different systems for describing the size of wiring cables in Pakistan.
 - 1.9 Describe points to be consider for the selection of cable for a particular application
 - 1.10 Calculate proper size of cable for a given load and conditions for both systems (Imperial and Metric)
 - 1.11 Define cable joint, distinguish between cable joint and cable termination.
 - 1.12 Describe the necessity and drawbacks of cable joints.
 - 1.13 Make list of tools and material required for making joints on wiring cables.
 - 1.14 Describe the steps of making joints on wiring cables (skinning, scrapping, jointing, soldering and tapping)
 - 1.15 Describe the correct procedure of making different wiring cable joints (Britannia, straight, Tee) on single core single stranded, single core multi stranded and multi core cables
 - 1.16 Enlist tools required for power cable jointing
 - 1.17 Describe the method of making joints of L.T & H.T power cables.

2. **UNDERSTAND THE WIRING ACCESSORIES AND WIRING SYSTEMS (PVC CONDUIT, AND CHANNEL WIRING SYSTEM).**
 - 2.1 Name electrical wiring accessories and their rating
 - 2.2 State purpose of each accessory.
 - 2.3 Name all domestic wiring systems.
 - 2.4 Describe procedure of installing wiring systems currently in practice (PVC conduit, and PVC Channel (PVC duct) wiring system).
 - 2.5 Compare PVC and metal conduit wiring system
 - 2.6 Compare surface and concealed conduit wiring system
 - 2.7 Enlist accessories and material used in both (PVC conduit, and PVC duct) wiring systems.
 - 2.8 Explain the advantages, disadvantages and uses of both the wiring systems,

3. **UNDERSTAND THE NEED FOR PROTECTION OF HOUSE WIRING AND KNOW**

DIFFERENT PROTECTIVE DEVICES FOR HOUSE WIRING.

- 3.1 Enlist types of protective devices for the protection of house wiring (fuses, MCB, MCCB and ELCB).
- 3.2 Define and distinguish between fuse MCB, MCCB and ELCB.
- 3.3 Describe construction of fuses, MCB, MCCB and ELCB.
- 3.4 Compare the advantages & disadvantages of fuse & MCB.

4. UNDERSTAND THE EARTHING SYSTEM USED IN HOUSE WIRING.

- 4.1 Name components of **equipment** earthing system.
- 4.2 Define earth electrode, earth continuity conductor & earthing lead.
- 4.3 Draw the earthing circuit.
- 4.4 Explain the earth fault current.
- 4.5 Describe electricity rules about domestic wiring and Earthing

5. UNDERSTAND THE CONSTRUCTION, NEED & APPLICATION OF DISTRIBUTION BOXES.

- 5.1 Define distribution box.
- 5.2 Describe need and proper location of distribution box.
- 5.3 Name Types of D.Bs. w.r.t. size, current rating, voltage, No. of C.Bs and phases etc.
- 5.4 **Describe** parts of a **typical** distribution Box.
- 5.5 **Describe distribution of single phase supply in small and multi storey buildings.**

6. UNDERSTAND THE WIRING TESTS & TEST INSTRUMENT (CONTINUITY TESTERS, TEST LAMP, and MEGGER).

- 6.1 Name different wiring tests.
- 6.2 Explain the procedure of each test and its result.

INDUSTRIAL & COMMERCIAL WIRING

1. UNDERSTAND POWER WIRING SYSTEMS (STEEL CONDUIT, TRUNKING & DUCTING, CATENARY, OVERHEAD BUSBAR, TROUGH SHEATHED SYSTEM).

- 1.1 Describe procedure of each **power** wiring system **mentioned above.**
- 1.2 Identify the material used in each wiring **system.**
- 1.3 **Enlist** uses of each wiring system.

2. UNDERSTAND MULTISTORY DISTRIBUTION SYSTEM.

- 2.1 Describe **three phase** electrical supply distribution system in **large commercial** and multistory buildings.
- 2.2 Illustrate a typical distribution system in a multistory building.
- 2.3 Draw block diagram of **three phase distribution in block of flats, large industrial building** and multistory building.

3. ACQUIRE THE SKILL IN INSTALLING POWER WIRING.

- 3.1 **Describe procedure to** install steel conduit wiring.

- 3.3 Describe procedure to install motor with DOL, 3 point & star-Delta starter.
- 3.4 Describe procedure to Dismantle & assemble I-ph and 3-ph motors.
- 3.5 Describe shortly the design of concrete foundation for motors
- 3.6 Describe steps to construct & level concrete motor foundation.
- 3.6 Locate & rectify faults in power wiring.

SAFETY AND REGULATION:

1. **UNDERSTAND THE HAZARDS TO LIFE AND EQUIPMENT FROM ELECTRICITY, ELECTRICAL & RELATED EQUIPMENTS - UNDERSTAND PRECAUTIONS WITH PREVENTIVE METHODS.**
 - 1.1 Describe general safety precautions to be observed in electrical labs/workshops
 - 1.2 State hazards to life from electric rotating machines.
 - 1.2 Explain preventive methods.
 - 1.3 Describe electric shock its prevention and treatment
 - 1.4 Describe fire and its types.
 - 1.5 Describe fire fighting equipments.
 - 1.6 Describe the principles of fire fighting.
2. **UNDERSTAND I.E.E. REGULATION FOR ELECTRICAL EQUIPMENTS OF BUILDING AND ELECTRICITY RULES OF PAKISTAN,**
 - 2.1 Describe the following I.E.E. regulations (A1,A3, A-26,B-4,B-12, C-4,C-6, D-1,D-20)
 - 2.2
 - 2.3 Explain Pakistan Electricity rules.No's 25, 28, 29, 32, 40, 49, 51, 52, 58, 60, 61, 62, 64)

BOOKS RECOMMENDED:

1. Electricity Rules (Pakistan).
2. I.E.E. Regulations London UK.
3. Modern wiring Practice By W.E Steward,
4. A Text book of Workshop Practice (Electrical Wiring) ET 146 By TEVTA Punjab, published by NBF

LIST OF PRACTICALS (ELECTRICAL WIRING)

192 Hrs.

1. To study wiring accessories.
2. To study tools used in wiring.
3. To study types of cables.
4. Demonstration of treatment against electric shock.
5. To control one lamp with a single way switch.
6. To control two lamps individually by 1-way switches.
7. To control three lamps individually by 3 one way switches & install a fuse.
8. To control two lamps individually by 2-way switch.
9. To control one lamp from 2 different places.(Stair case circuit).
10. To control one lamp from 3 different places.
11. To control three lamps in series and measure voltage drop across each lamp.
12. To construct a test board.
13. To construct fuse indication circuit.
14. To control two lamps by two 2-way switches both in series, both in parallel and individual control.
15. To control a bell through indicator by push button.
16. To prepare Bell-indicator circuit (Hotelling circuit).
17. To prepare Go down circuit.
18. Study of wiring boxes and sealing.
19. To prepare single twist joint.
20. To prepare married joint.
21. To prepare duplex joint.
22. To prepare rat-tail joint.
23. To prepare a Britannia joint.
24. Study of low power cables.
25. Study of medium power cables.
26. Jointing of low voltage cables.
27. Jointing of medium voltage cables.
28. Jointing of paper cables.
29. To prepare wiring switch board with 4 switches, one fan regulator, one socket and a lamp.
30. Study of various protective devices.
31. To control one lamp in channel wiring.
32. To control two lamps in channel wiring.
33. To control three lamps in channel wiring.
34. Bell indicator circuit in channel wiring.
35. Go down circuit in channel wiring.
36. To install 1-phase energy meter, main switch and distribution fuse board.
37. To Control One lamp in P.V.C. conduit wiring by making circuit at serial No.9.
38. To control two lamps in P.V.C. conduit wiring by making circuit at serial No.10.
39. To control three lamps in P.V.C. conduit wiring by making circuit at serial No.14.
40. Stair case circuit in P.V.C. by making circuit at serial No.16.
41. Tunnel light circuit in P.V.C. wiring.
42. To control three lamps individually in steel conduit.

43. Stair case circuit in steel conduit.
44. Bell indicator circuit in steel conduit.
45. Fluorescent lamp parts and its connection.
46. To study & connect starter-less fluorescent lamp.
47. Wiring 3-phase motor contractor, push button starter and thermal relay.
48. Wiring 3-phase motor as above but controlled from more than one place.
49. Study of the various AC and DC motor starters.
50. Wiring 3-phase motor with 3 position starter. (forward, stop, reverse)
51. Typical commercial wiring in conduit, having distributed light and power circuit.
52. Demonstration of electric shock treatment.
53. Study of different fire extinguisher.
54. House wiring test (Short circuit, leakage current, polarity and continuity test).
55. Location of fault and rectification in wiring.
56. Measurement of earth resistance by earth tester.
57. Measurement of earth loop resistance by Ammeter and volt meter method.
58. Insulation test of 3-phase motors by Megger.
59. Designing Protective Multiple Earth System for industrial installation.

ET-153 WORKSHOP PRACTICE (Mechanical)

T P C
0 9 3

Total Contact Hours:

Theory: 0
Practical: 288

- 1 A.) METAL WORK 96 Hrs.**
 - 1.1. Shop orientation.**
 - 1.1.1. Shop policy, rules and regulation.
 - 1.1.2. Introduction to shop machines.
 - 1.2. Workshop safety practices.**
 - 1.2.1. Measuring tools.
 - 1.2.2. Cutting tools.
 - 1.2.3. Marking tools.
 - 1.2.4. Layout tools.
 - 1.2.5. Grinding tools.
 - 1.2.6. Stocking tools.
 - 1.2.7. Stakes.
 - 1.3. Bench Work.**
 - 1.3.1. Metal sawing.
 - 1.3.2. Metal filing.
 - 1.3.3. Metal fitting.
 - 1.3.4. Metal drilling.
 - 1.3.5. Pipe cutting/threading
 - 1.3.6. Sheet metal work.
 - 1.3.7. Riveting.

METAL WORK (SHOP TALK ONLY) - NO THEORY PAPER:

- 1. BE FAMILIAR WITH THE SHOP AREA POLICIES AND DIFFERENT TOOLS & EQUIPMENT SUPPORTIVE TO BENCH WORK. SHOW CONCERN FOR SAFETY.**
 - 1.1 Classify the tools and equipment which supports bench work.
 - 1.2 Identify the different parts and functions of the support machines.
 - 1.3 Follow proper operating procedure, care and maintenance of different tools and support machines.
 - 1.4 Observe shop safety practice.

- 2. APPLY THE VARIOUS KNOWLEDGE AND MANIPULATE SKILLS ACQUIRED IN BENCH WORK PROCESS.**
 - 2.1 Identify various tools and equipment used in bench work.
 - 2.2 Perform various bench work processes.
 - 2.3 Demonstrate proper use, care and maintenance of various hand tools.
 - 2.4 Select proper tools.
 - 2.5 Identify parts and functions of hand tools.

- 2.6 Solve shop problems related to bench work.
- 2.7 Observe safety rules applied to bench work processes.

LIST OF PRACTICALS (METAL WORK)

- 1. Preparation of name plate (for the practice of cutting, filling, drilling and sawing) **9 Hrs.**
- 2. Sawing exercise **9 Hrs.**
- 3. Preparation of inside & outside calipers (for the practice of cutting, filling, sizing drilling and riveting) **9 Hrs.**
- 4. Preparation of bottle opener (for the practice of cutting, filling, and sizing) **9 Hrs.**
- 5. Preparation of dove-tail joint (for the practice of cutting, filling, and sizing) **9 Hrs.**
- 6. Preparation of small size try-square **6 Hrs.**
- 7. Practice of G.I pipe cutting threading and reaming (for the practice of pipe cutting, and threading) **6 Hrs.**
- 8. Preparation of funnel (sheet) (for the practice of sheet cutting and fitting) **6 Hrs.**
- 9. Preparation of pin tray (sheet) (for the practice of sheet cutting and fitting) **6 Hrs.**
- 10. Preparation of drawer handle) (for the practice of bending and drilling) **6 Hrs.**
- 11. Preparation of bevel square(for the practice of drilling, fitting and riveting) **9 Hrs.**
- 12. Preparation of spanner (small size) (for the practice of cutting, filling, and sizing) **9 Hrs.**

B) WELDING.

- 1.1. **Shop orientation.**
 - 1.1.1 Shop policies, shop rules and regulation.
 - 1.1.2 Workshop safety practices.
- 1.2. **Introduction to welding process and welding equipment.**
 - 1.2.1 Welding process.
 - 1.2.2 Welding torches.
 - 1.2.3 Gas cylinders.
 - 1.2.4 Pressure gauges.
 - 1.2.5 Welding flames.
 - 1.2.6 Arc welding and related equipment.
 - 1.2.7 Fluxes.
 - 1.2.8 Soldering.

WELDING (SHOP INSTRUCTIONS TALK ONLY)-NO THEORY PAPER:

- 1. **UNDERSTAND TOOLS AND EQUIPMENT USED IN GAS WELDING, ARC WELDING AND SOLDERING - KNOW AND APPLY THE WELDING AND SOLDERING PROCESSES.**
 - 1.1 Identify the tools and equipment used in basic welding (Gas, Arc) and soldering processes.
 - 1.2 Select proper tools and material.
 - 1.3 Weld common joints.
 - 1.4 Solder joints.
 - 1.5 Follow proper procedure.
 - 1.6 Observe safety practice

LIST OF PRACTICALS (WELDING)

(Gas Welding)

- | | |
|-------------------------------------|---------------|
| 1. Flame making practice. | 3 Hrs. |
| 2. Pool making. | 3 Hrs. |
| 3. Bead making. | 3 Hrs. |
| 4. Butt joint. | 3 Hrs. |
| 5. Lap joint. | 6 Hrs. |
| 6. Corner joint without filler rod. | 6 Hrs. |
| 7. Corner joint with filler rod. | 6 Hrs. |
| 8. T. joint. | 6 Hrs. |
| 9. Edge joint. | 6 Hrs. |
| 10. Brazing practice. | 6 Hrs. |

(ARC Welding)

- | | |
|---|---------------|
| 11. ARC making/current setting/polarity selection | 6 Hrs. |
| 12. Bead making | 3 Hrs. |
| 13. Butt joint | 6 Hrs. |
| 14. Lap joint | 6 Hrs. |

15.	Corner joint	6 Hrs.
16.	T. joint	3 Hrs.
17.	V. Butt joint	3 Hrs.
18.	Square corner joint	6 Hrs.
19.	Bevel butt joint	3 Hrs.
20.	Spot Welding	3 Hrs.

C) BASIC MACHINE SHOP

Total Contact Hours		T	P	C
Practical	96	0	3	1
Theory	0			

AIM The course aims at providing necessary skill in the use of tools/machines for basic machine shop operations. Also, this will provide an opportunity for the familiarization with the basic production processes in the factory.

COURSE CONTENTS (LAB.- THEORY); (NO THEORY PAPER)

1. SHOP ORIENTATION.

- 1.1 Shop policies - rules and regulation.
- 1.2 Workshop safety practices.

2. INTRODUCTION TO MACHINES AND TOOLS.

- 2.1 Grinder.
- 2.2 Lathe and allied equipments.
- 2.3 Micrometer, outside and inside calipers.
- 2.4 Knurling tools.
- 2.5 Thread gauge.

3. INTRODUCTION TO NUMERICAL CONTROL

- 3.1 Numerical Control Theory
- 3.2 NC Machine Tool Operations

4. NC MACHINE TOOL CHARACTERISTICS

- 4.1 NC Machine Tool Characteristics and Types
- 4.2 NC Machine Tool Structure, Names of Parts and Their Functions
- 4.3 Use of NC Machine Tools

INSTRUCTIONAL OBJECTIVES

1. KNOW THE ESSENTIAL PARTS AND FUNCTIONS OF GRINDERS AND LATHE.

2. UNDERSTAND THE OPERATIONS OF LATHE AND GRINDERS.

- 1.1. Identify parts of lathe and grinder.
- 1.2 State the functions of lathe.
- 1.3 Know different types of threads and their measuring tools.
- 1.4 Practice turning by observing proper procedure (Simple turning, taper turning, Knurling).
- 1.5 Measure thread with thread gauge.
- 1.6 Observe safety precautions in machine shop.
- 1.7 Appreciate quality of workmanship in the job.
- 1.8 Realize the use of connect type of tool and operation for a given job.

3. INTRODUCTION OF NUMERICAL CONTROL

- 3.1 Describe Numerical Control Theory
- 3.2 Describe NC Machine Tool Operation
- 3.3 Describe History of NC Machine Tool Development
- 3.4 Describe Production Trends of NC Machine Tools

4. NC MACHINE TOOL CHARACTERISTICS

- 4.1 Describe NC Machine Tool Characteristics and Types
- 4.2 Describe NC Machine Tool Structure, Names of Parts and Their Functions
- 4.3 Describe Use of NC Machine Tools

c) BASIC MACHINE SHOP

LIST OF PRACTICALS

96 Hours

- 1-2. Practice for centering the job by surface gauge method.
3. Tool bit grinding.
- 4-5. Simple turning and facing practice.
6. Practice of counter-sinking.
7. Practice drilling on lathe.
8. Practice of step turning.
9. Knurling practice.
- 10-11. Practice of taper turning by compound rest method.
- 12-13. Practice of taper turning by offset method.
- 14-15. Metric thread cutting practice.
- 16-17. Practice of V-threads in inch system.
- 18-19. Drilling practice.
20. Drill grinding practice on tool grinder.
21. **Profile Diagram and Main Part Name of Machining Center, Turning Center and Wire Cut.**
22. **Controller Specification**
23. **Hydraulic and Pneumatic System (Coolant, Air)**

1. سورة التوہون آیت تا آیہ آیات کا معنی
2. دن تخبہ مصلحت مع زمرہ و تفریح
3. خیار کم من تعسیم القرآن و علمہ
4. لا ایمان لمن لا امانتہ لہ ولا دین لمن لا عہدہ
5. وراکم و لظن ان الظن اکرب الحدیث
6. من احدث فی امرنا بئنا ما لیس متہ فہو رد
7. من جعل علیہ السلاح فلیس منا
8. لادو کفیل البیتیم فی الجنۃ
9. لا ضرور ولا ضرار فی السلام
10. کلکم راع و کلکم راع و کلکم مسؤل عن رعیتہ
11. 3- میرا طیبہ
12. کی زندگی و ارثہ بختہ اجرت
13. خلی زندوں - موافقت - مشق درند - حج کد (اسباب و نتائج)
14. حضور ﷺ بحیثیت
15. طبہ حینہ الامراہ
16. معہ کل سرہر کو خاندان
17. 5. اسلامی معاشرہ
18. کلام تعلیم نور ان کے مقاصد، عدس و انصاف - امر بالمعروف نہی عن المنکر
19. جملہ - کسب طالب - سچا اکیسیت (فضیلت)
20. انسانی رہاست کی تعریف - انسانی رہاست کی خصوصیات - انسانی حکومت کے فرائض - اسلامی طرز حکومت

اسلامیات

تدریس مقاصد

عمومی مقاصد بطالعلم یہ جان سکے کہ آیات قرآنی کی روشنی میں مومن کے اوصاف کیا ہیں
قرآن مجید
فصوصی مقاصد:

☆ قرآنی آیات کا ترجمہ بیان کر سکے

☆ قرآنی آیات کی تشریح کر سکے

☆ قرآنی آیات کی روشنی میں ایک مومن کے اوصاف بیان کر سکے

☆ قرآنی آیات میں بیان کردہ مومن کے اوصاف اپنے اندر پیدا کر سکے

احادیث نبویہ

☆ عمومی مقصد احادیث کی روشنی میں اسلامی اخلاقی اقدار (انفرادی و اجتماعی) سے آگاہ ہو سکے

فصوصی مقاصد:

☆ احادیث کا ترجمہ بیان کر سکے

☆ احادیث کی تشریح کر سکے

☆ احادیث کی روشنی میں اسلام کی اخلاقی اقدار کی وضاحت کر سکے

☆ فقہ احادیث کی دی گئی تفہیمات کے مطابق اپنی زندگی گزار سکے

سیرت طیبہ

☆ عمومی مقصد: حضور ﷺ کی سیرت طیبہ کے بارے میں جان سکے

فصوصی مقاصد:

☆ حضور ﷺ کی ابتدائی زندگی اختصار کے ساتھ بیان کر سکے

☆ حضور ﷺ کی ہجرت کا واقعہ بیان کر سکے

☆ حضور ﷺ کی مدنی زندگی اختصار سے بیان کر سکے

☆ حضور ﷺ کی بطور معلم خصوصیات بیان کر سکے

☆	حضور ﷺ کی بطور سربراہ خاندان بیان کر سکے
	اسلامی معاشرہ
	عمومی مقصد: اسلامی معاشرہ کی خصوصیات سے آگاہی حاصل کر سکے
	خصوصی مقاصد:
☆	اسلامی معاشرہ کا معنی و مفہوم بیان 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 و 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
☆	اقل مسیحی کی تعریف کر سکے

نصاب مطالعہ پاکستان

نی بی سی
1 0 1
کل وقت: 12 گھنٹے

سلاں دوم

حصہ دوم

موضوعات

☆	یہ قون نظر
☆	تحریک پاکستان
☆	انڈین کانگریس
☆	مسلم لیگ
☆	تفسیر بنگلہ
☆	سینٹ کیمسٹر
☆	تحریک خلافت
☆	سندھ تحریک
☆	تجلیوزارمی
☆	سورپورٹ
☆	قائمہ اعظم کے چودہ نکات
☆	خلیفہ آل انڈیا
☆	انتخابات 1938 اور انٹل ہنزدار
☆	قرارداد پاکستان

حصہ دوم

سزاخار پاکستان

تدریس مقاصد

تحریک پاکستان

عمومی مقصد: قیام پاکستان کے اسباب و محرکات کو بیان کر سکتے

خصوصی مقاصد:

☆ قومیت کے مفہوم کو بیان کر سکے

☆ دو قومی نظریہ کی تعریف و توضیح کر سکے

☆ دو قومی نظریہ اہمیت بیان کر سکے

☆ ہندوستانی مسلمانوں کی محرومیوں کو بیان کر سکے

☆ قومی تشخص کو بحال رکھنے کے لئے مسلمان ہند کی مسابقتی بیان کر سکے

☆ آزادی ہند اور قیام پاکستان علامہ اقبال اور قائد اعظم کی مسابقتی بیان کر سکے

☆ قیام پاکستان سے مستقبل اسلامی مملکت کے قیام کے لئے مسلم عوام کی کوششوں کو بیان کر سکے

☆ مسلم لیگ کے قیام پاکستان کے لئے جدوجہد بیان کر سکے

(غیر مسلم طلباء کے لئے)

نی نی نی
1 0 1
کل وقت: 20 منٹ

نصاب امتلاقیات
سال دوم

موضوعات

معاشرتی قدرات، ایمان، قوم، قوی سطح، شہری سطح، صنعتی اربابوں کی سطح، ضروریات، درجہ

☆ حقوق و فرائض

☆ قوت پرورش

☆ قوت ارادی

☆ نکلن و جذبہ

☆ وسیع نظری

☆ بے غرضی

☆ مسئلہ دوستی

☆ صحافتی شعور

☆ پاس آزدی

☆ کمال اچھی

☆ تعمیرات کو قبول کرنا

☆ خود شناسی

نسب اخلاقیات

سال ۲۰۲۳

تدریس مقاصد

عمومی مقاصد:

طالب علم: اخلاقیات کی اہمیت و ضرورت سے سمجھ ہو سکے اور بیان کر سکے

خصوصی مقاصد: طالب علم اس قتل ہو کہ

موضوعات کا مطلب بیان کر سکے

عملی زندگی سے مثالوں کی نشاندہی کر سکے

اپنی شخصیت اور حاشیہ پر موضوعات کے مطابق مثبت اثرات پیدا کرنے کے طریقے بیان کر سکے

اعلیٰ اخلاقی قداریں سے

توبت برداشت۔ قوت ارادی۔ مکتبہ جذبہ۔ وسیع النظری۔ بے غرض۔ انسانی دوستی خالص۔ شعور۔ پس تزاری۔

کمال اعلیٰ اور نوازشی کی اہمیت بیان کر سکے

اخلاقیات سے شغف ہو کر قومی خدمت بہتر طور پر انجام دے سکے

MATH-233 APPLIED MATHEMATICS-II

Total Contact Hours

Theory	96	T	P	C
Practical	0	3	0	3

Pre-requisite: Must have completed Mathematics-I.

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

Solve problems of Calculus, Laplace Transformation and Fourier Series, and develop mathematical skills and logical perceptions in the use of mathematical instruments.

COURSE CONTENTS

- 1. FUNCTIONS & 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 and $(ax + b)^n$
 - 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 Cosec x, Sec x, Cot x
 - 4.3 Differential Coefficient of Inverse trigonometric functions.
 - 4.4 Problems.

- 5. DIFFERENTIATION OF LOGARITHMIC & EXPONENTIAL FUNCTIONS 6 hours**
- 5.1 Differentiation of $\ln x$
 - 5.2 Differentiation of $\text{Log } a^x$
 - 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
 - 6.3 Criteria for maximum & minimum values
 - 6.4 Methods of finding maximum & minimum
 - 6.5 Rate measure
 - 6.6 Slope of a line
 - 6.7 Velocity and acceleration
 - 6.8 Problems
- 7. INTEGRATION(SIMPLE BASIC RULES) 9 hours**
- 7.1 Concept
 - 7.2 Fundamental Formulas
 - 7.3 Important Rules
 - 7.4 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 Order and Degree
 - 10.3 First order Differential Equation of 1st degree.
 - 10.4 Solution of problems
 - 10.5 Problems
- 11. LAPLACE TRANSFORMATIONS 9 hours**
- 11.1 Laplace Transformations
 - 11.2 Inverse Laplace Transformations
 - 11.3 Problems.
- 12. FOURIER SERIES. 9 hours**

- 12.1 Introduction
- 12.2 Periodic Functions
- 12.3 Even and Odd Functions
- 12.4 Problems

13. STATISTICS

9 hours

- 13.1 Concept of mean, median and mode
- 13.2 Standard Deviation
- 13.3 Laws of probability
- 13.4 Problems

RECOMMENDED BOOKS:-

1. Text Book of Math-233, developed by Curriculum Section, Academics wing TEVTA and published by National Book Foundation (NBF).

MATH-233 APPLIED MATHEMATICS-II

INSTRUCTIONAL OBJECTIVES

- 1. USE THE CONCEPT OF FUNCTIONS AND THEIR LIMITS IN SOLVING SIMPLE PROBLEMS.**
 - 1.1 Define a function.
 - 1.2 List all types 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 simple problems on limits.

- 2. UNDERSTAND THE CONCEPT OF DIFFERENTIAL COEFFICIENT.**
 - 2.1 Define differential coefficient.
 - 2.2 Derive mathematical expression of a derivative.
 - 2.3 Explain geometrically the meaning of differential coefficient.
 - 2.4 Differentiate ab-initio x^n and $(ax+b)^n$.
 - 2.5 Solve problems of these formulas.

- 3. USE RULES OF DIFFERENTIATION FOR SOLVING PROBLEMS OF ALGEBRAIC FUNCTIONS.**
 - 3.1 Derive product rule, quotient rule and chain rule.
 - 3.2 Interpret the chain rule.
 - 3.3 Differentiate explicit and implicit functions.
 - 3.4 Find derivatives of parametric forms of a function w.r.t another function, by rationalization.
 - 3.5 Use these important rules to find derivatives of relevant functions.

- 4. USE RULES OF DIFFERENTIATION TO SOLVE TRIGONOMETRIC FUNCTIONS.**
 - 4.1 Differentiate from first principle $\sin x$, $\cos x$, $\tan x$.
 - 4.2 Derive formulas for derivatives of $\sec x$, $\operatorname{cosec} x$, $\cot x$.
 - 4.3 Find derivatives 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 coefficients of logarithmic and exponential functions.
 - 5.2 Solve problems using these formulae.

- 6. UNDERSTAND RATE OF CHANGE OF ONE VARIABLE WITH ANOTHER**
 - 6.1 Derive formulas for velocity, acceleration and slope of a line
 - 6.2 Use derivative as a measure of rate of change.
 - 6.3 Explain an increasing and a decreasing function.
 - 6.4 Show graphically maxima and minima values and point of inflexion.
 - 6.5 Explain criteria for finding maxima and minima.

6.6 Solve problems based upon these topics.

7. USE PRINCIPLES OF INTEGRATION IN SOLVING RELEVANT PROBLEMS.

- 7.1 Explain concept of integration.
- 7.2 Write basic theorems of integration.
- 7.3 Define fundamental formulas of integration.
- 7.4 List some important rules of integration.
- 7.5 Solve problems based on these rules.

8. UNDERSTAND VARIOUS METHODS OF INTEGRATION

- 8.1 List standard formulas of integration.
- 8.2 Integrate a function by substitution method.
- 8.3 Use method of integration by parts for finding integrals.
- 8.4 Employ these methods to solve problems.

9. UNDERSTAND THE METHODS OF SOLVING DEFINITE INTEGRALS.

- 9.1 Define definite integral.
- 9.2 List properties of definite integrals.
- 9.3 Use definite integral in the computation of areas.
- 9.4 Solve problems involving 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 for solving differential equations of first order and first degree.
- 10.3 Solve differential equations of first order and first degree.

11. USE LAPLACE AND INVERSE LAPLACE TRANSFORMATION FOR SOLVING PROBLEMS.

- 11.1 Define Laplace and Inverse Laplace Transformation
- 11.2 List properties of Laplace Transformation
- 11.3 Solve problems using Laplace Transformations

12. EXPAND FUNCTIONS USING FOURIER SERIES

- 12.1 Define a Fourier series.
- 12.2 Write extended rule of integration by parts.
- 12.3 Illustrate periodic functions, even and odd functions.
- 12.4 Explain Fourier expansion and Fourier constants.
- 12.5 Expand the given functions of Fourier series.

13. UNDERSTAND THE BASIC CONCEPTS OF STATISTICS

- 13.1 Define mean, median and mode
- 13.2 Explain standard deviation
- 13.3 State laws of probability
- 13.4 Calculate the above mentioned quantities using the proper formula

PHY-222 APPLIED PHYSICS

Total Contact Hours

Theory	32	T	P	C
Practicals	96	1	3	2

AIMS The students will be able to understand the fundamental principles and concept of physics, use these to solve problems in practical situations/technological courses and understand concepts to learn advance physics/technical courses.

COURSE CONTENTS

- 1 MEASUREMENTS. 2 Hours.**
 - 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. 4 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 WAVE MOTION. 5 Hours**
 - 3.1 Review Hooke's law of elasticity
 - 3.2 Motion under an elastic restoring force
 - 3.3 Characteristics of simple harmonic motion
 - 3.4 S.H.M. and circular motion
 - 3.5 Simple pendulum
 - 3.6 Wave form of S.H.M.
 - 3.7 Resonance
 - 3.8 Transverse vibration of a stretched string

- 4 SOUND. 5 Hours**
 - 4.1 Longitudinal waves
 - 4.2 Intensity, loudness, pitch and quality of sound
 - 4.3 Units of Intensity of level and frequency response of ear
 - 4.4 Interference of sound waves silence zones, beats
 - 4.5 Acoustics
 - 4.6 Doppler effect.

- 5 LIGHT. 5 Hours**
 - 5.1 Review laws of reflection and refraction

- 5.2 Image formation by mirrors and lenses
 - 5.3 Optical instruments
 - 5.4 Wave theory of light
 - 5.5 Interference, diffraction, polarization of light waves
 - 5.6 Applications of polarization in sunglasses, optical activity and stress analysis
- 6 OPTICAL FIBER. 2 Hours**
- 6.1 Optical communication and problems
 - 6.2 Review total internal reflection and critical angle
 - 6.3 Structure of optical fiber
 - 6.4 Fiber material and manufacture
 - 6.5 Optical fiber - uses.
- 7 LASERS. 3 Hours**
- 7.1 Corpuscular theory of light
 - 7.2 Emission and absorption of light
 - 7.3 Stimulated absorption and emission of light
 - 7.4 Laser principle
 - 7.5 Structure and working of lasers
 - 7.6 Types of lasers with brief description.
 - 7.7 Applications (basic concepts)
 - 7.8 Material processing
 - 7.9 Laser welding
 - 7.10 Laser assisted machining
 - 7.11 Micro machining
 - 7.12 Drilling, scribing and marking
 - 7.13 Printing
 - 7.14 Lasers in medicine
- 8 HEAT. 4 hrs.**
- 8.1 Review of calorimetry and gas laws
 - 8.2 Thermal expansion of solids, liquids and gases
 - 8.3 Heat of fusion, vaporization
 - 8.4 Humidity, absolute and relative
 - 8.5 Law of cooling
 - 8.6 Thermoelectricity
 - 8.7 Thermocouple.
- 9 MAGNETIC MATERIALS. 2 Hours**
- 9.1 Magnetism
 - 9.2 Domains theory
 - 9.3 Para, dia and ferromagnetism and magnetic materials
 - 9.4 B.H. curve and hysteresis loop.

10 SEMI CONDUCTOR MATERIALS.

2 Hours

- 10.1 Crystalline structure of solids
- 10.2 Conductors, semiconductors, insulators
- 10.3 P-type and N-type materials
- 10.4 P-N junction
- 10.5 P-N junction as a diode
- 10.6 Photovoltaic cell (solar cell)

RECOMMENDED BOOKS:-

- 1 Text Book of Phy-222, developed by Curriculum Section, Academics wing, TEVTA and published by National Book Foundation (NBF)

PHY-222 APPLIED PHYSICS

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 of vectors.

3 USE CONCEPTS OF WAVE MOTION IN SOLVING RELEVANT PROBLEMS.

- 3.1 Explain Hooke's Law of Elasticity
- 3.2 Derive formula for Motion under an elastic restoring force
- 3.3 Derive formulae for simple harmonic motion and simple pendulum
- 3.4 Explain wave form with reference to S.H.M. and circular motion
- 3.5 Explain Resonance
- 3.6 Explain Transverse vibration of a stretched string
- 3.7 Use the above concepts and formulae of S.H.M. to solve relevant problems.

4 UNDERSTAND CONCEPTS OF SOUND.

- 4.1 Describe longitudinal wave and its propagation
- 4.2 Explain the concepts: Intensity, loudness, pitch and quality of sound
- 4.3 Explain units of Intensity of level and frequency response of ear
- 4.4 Explain phenomena of silence zones, beats
- 4.5 Explain Acoustics of buildings
- 4.6 Explain Doppler effect giving mathematical expressions.

5 USE THE CONCEPTS OF GEOMETRICAL OPTICS TO MIRRORS and LENSES.

- 5.1 Explain laws of reflection and refraction
- 5.2 Use mirror formula to solve problems
- 5.3 Use the concepts of image formation by mirrors and lenses to describe working of optical instruments, e.g. microscopes, telescopes, camera and sextant.

- 6 UNDERSTAND WAVE THEORY OF LIGHT**
- 6.1 Explain wave theory of light
 - 6.2 Explain phenomena of interference, diffraction, polarization of light waves
 - 6.3 Describe uses of polarization given in the course contents.
- 7 UNDERSTAND THE STRUCTURE, WORKING AND USES OF OPTICAL FIBER.**
- 7.1 Explain the structure of the Optical Fiber
 - 7.2 Explain its principle of working
 - 7.3 Describe use of optical fiber in industry and medicine.
- 8 UNDERSTAND THE STRUCTURE, WORKING AND USES OF LASERS.**
- 8.1 Explain the stimulated emission of radiation
 - 8.2 Explain the laser principle
 - 8.3 Describe the structure and working of lasers
 - 8.4 Distinguish between types of lasers
 - 8.5 Describe the applications of lasers in the fields mentioned in the course contents.
- 9 UNDERSTAND TYPES AND USES OF ARTIFICIAL SATELLITES.**
- 9.1 Explain escape velocity
 - 9.2 Explain orbital velocity
 - 9.3 Distinguish between geosynchronous and geostationary satellites
 - 9.4 Describe uses of artificial satellites in data communication.
- 10 UNDERSTAND BASIC CONCEPTS AND CLASSIFICATION OF MAGNETIC MATERIALS.**
- 10.1 Explain domains theory of magnetism
 - 10.2 Distinguish between para, dia and ferromagnetism and magnetic materials
 - 10.3 Distinguish between B and H
 - 10.4 Describe B.H. Curve
 - 10.5 Describe hysteresis loop.
- 11 UNDERSTAND BASIC CONCEPTS OF SEMI-CONDUCTOR MATERIALS AND THEIR USES.**
- 11.1 Explain crystalline structure of solids
 - 11.2 Distinguish between conductors, semiconductors and insulators
 - 11.3 Describe semiconductors giving examples with reference to their structure
 - 11.4 Distinguish between P-type and N-type materials
 - 11.5 Explain working of P-N junction as a diode
 - 11.6 Explain working of solar cell.

PHY-222 APPLIED PHYSICS

LIST OF PRACTICALS.

- 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 fletchers' 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 Modulus 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 lens 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 (magnifying 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.

MGM-221 BUSINESS MANAGEMENT AND INDUSTRIAL ECONOMICS

Total Contact Hours

Theory	32	T	P	C
Practical	0	1	0	1

AIMS The students will be able to develop management skills, get acquainted the learner with the principles of management and economic relations and develop commercial/economic approach to solve the problems in the industrial set-up.

COURSE CONTENTS

- 1. ECONOMICS** **2 Hours**
 - 1.1 Definition: Adam Smith, Alfred Marshall, Prof. Robins.
 - 1.2 Nature and scope
 - 1.3 Importance for technicians
 - 1.4 Micro and Macro Economics.

- 2. BASIC CONCEPTS OF ECONOMICS** **1 Hour**
 - 2.1 Utility
 - 2.2 Income
 - 2.3 Wealth
 - 2.4 Saving
 - 2.5 Investment
 - 2.6 Value.

- 3. DEMAND AND SUPPLY.** **2 Hours**
 - 3.1 Definition of demand.
 - 3.2 Law of demand.
 - 3.3 Definition of supply.
 - 3.4 Law of supply.

- 4. FACTORS OF PRODUCTION.** **2 Hours**
 - 4.1 Land
 - 4.2 Labour
 - 4.3 Capital
 - 4.4 Organization.

- 5. BUSINESS ORGANIZATION.** **3 Hours**
 - 5.1 Sole proprietorship.
 - 5.2 Partnership
 - 5.3 Joint stock company.

- | | | |
|------------|---|----------------|
| 6. | ENTREPRENEURIAL SKILLS | 4 Hours |
| 6.1 | Preparing, planning, establishing, managing, operating and evaluating relevant resources in small business. | |
| 6.2 | Business opportunities, goal setting. | |
| 6.3 | Organizing, evaluating and analyzing opportunity and risk tasks. | |
| 7. | SCALE OF PRODUCTION. | 2 Hours |
| 7.1 | Meaning and its determination. | |
| 7.2 | Large scale production. | |
| 7.3 | Small scale production. | |
| 8. | ECONOMIC SYSTEM | 3 Hours |
| 8.1 | Free economic system. | |
| 8.2 | Centrally planned economy. | |
| 8.3 | Mixed economic system. | |
| 9. | MONEY. | 1 Hour |
| 9.1 | Barter system and its inconveniences. | |
| 9.2 | Definition of money and its functions. | |
| 10. | BANK. | 1 Hour |
| 10.1 | Definition | |
| 10.2 | Functions of a commercial bank. | |
| 10.3 | Central bank and its functions. | |
| 11. | CHEQUE | 1 Hour |
| 11.1 | Definition | |
| 11.2 | Characteristics and kinds of cheque. | |
| 11.3 | Dishonour of cheque. | |
| 12. | FINANCIAL INSTITUTIONS | 2 Hours |
| 12.1 | IMF | |
| 12.2 | IDBP | |
| 12.3 | PIDC | |
| 13. | TRADE UNION | 2 Hours |
| 13.1 | Introduction and brief history. | |
| 13.2 | Objectives, merits and demerits. | |
| 13.3 | Problems of industrial labour. | |
| 14. | INTERNATIONAL TRADE. | 2 Hours |
| 14.1 | Introduction | |

14.2	Advantages and disadvantages.	
15.	MANAGEMENT	1 Hour
15.1	Meaning	
15.2	Functions	
16.	ADVERTISEMENT	2 Hour
16.1	The concept, benefits and draw-backs.	
16.2	Principal media used in business world.	
17.	ECONOMY OF PAKISTAN	1 Hour
17.1	Introduction	
17.2	Economic problems and remedies.	

BOOKS RECOMMENDED

1. Nisar-ud-Din, Business Organization, Aziz Publisher, Lahore
2. M. Saeed Nasir, Introduction to Business, Ilmi Kitab Khana, Lahore.
3. S.M. Akhtar, An Introduction to Modern Economics, United Limited, Lahore.

MGM-221 BUSINESS MANAGEMENT AND INDUSTRIAL ECONOMICS.

INSTRUCTIONAL OBJECTIVES

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 of economics for technicians.
- 1.4 Distinguish between Micro and Macro Economics

2. UNDERSTAND BASIC TERMS USED IN ECONOMICS.

- 2.1 Define basic terms, utility, income, wealth, saving, investment and value.
- 2.2 Explain the basic terms with examples

3. UNDERSTAND LAW OF DEMAND AND LAW OF SUPPLY.

- 3.1 Define Demand.
- 3.2 Explain law of demand with the help of schedule and diagram.
- 3.3 State assumptions and limitation of law of demand.
- 3.4 Define Supply.
- 3.5 Explain law of Supply with the help of schedule and diagram.
- 3.6 State assumptions and limitation of law of supply.

4. UNDERSTAND THE FACTORS OF PRODUCTION

- 4.1 Define the four factors of production.
- 4.2 Explain labour and its features.
- 4.3 Describe capital and its peculiarities.

5. UNDERSTAND FORMS OF BUSINESS ORGANIZATION.

- 5.1 Describe sole proprietorship, its merits and demerits.
- 5.2 Explain partnership, its advantages and disadvantages.
- 5.3 Describe joint stock company, its merits and demerits.
- 5.4 Distinguish public limited company and private limited company.
- 5.5 Difference between proprietorship, partnership and joint stock company

6. UNDERSTAND ENTREPRENEURIAL SKILLS

- 6.1 Explain preparing, planning, establishing and managing small business set up
- 6.2 Explain evaluating all relevant resources
- 6.3 Describe organizing analyzing and innovation of risk of task

7. UNDERSTAND SCALE OF PRODUCTION.

- 7.1 Explain scale of production and its determination.
- 7.2 Describe large scale production and its merits.

- 7.3 Explain small scale of production and its advantages and disadvantages.
- 8. UNDERSTAND DIFFERENT ECONOMIC SYSTEMS.**
- 8.1 Describe free and centrally planned economic system and its characteristics.
- 8.2 Merits and demerits of economic system.
- 9. UNDERSTAND WHAT IS MONEY**
- 9.1 Define money
- 9.2 Explain barter system and its inconveniences.
- 9.3 Explain functions of money.
- 10. UNDERSTAND BANK AND ITS FUNCTIONS.**
- 10.1 Define bank.
- 10.2 Describe commercial bank and its functions.
- 10.3 State central bank and its functions.
- 10.4 Kind of accounts which are opened into a bank.
- 11. UNDERSTAND CHEQUE AND DISHONOR OF CHEQUE.**
- 11.1 Define cheque.
- 11.2 Enlist the characteristics of cheque.
- 11.3 Identify the kinds of cheque.
- 11.4 Describe the causes of dishonor of a cheque.
- 12. UNDERSTAND FINANCIAL INSTITUTIONS.**
- 12.1 Explain IMF and its objectives.
- 12.2 Explain organisational set up and objectives of IDBP.
- 12.3 Explain organisational set up and objectives of PIDC.
- 12.4 Explain function of SBP.
- 13. UNDERSTAND TRADE UNION, ITS BACKGROUND AND FUNCTIONS.**
- 13.1 Describe brief history of trade union.
- 13.2 State functions of trade union.
- 13.3 Explain objectives, merits and demerits of trade unions.
- 13.4 Enlist problems of industrial labour.
- 14. UNDERSTAND INTERNATIONAL TRADE.**
- 14.1 Explain international trade.
- 14.2 Enlist its merits and demerits.
- 15. UNDERSTAND MANAGEMENT**
- 15.1 Explain meaning of management.
- 15.2 Describe functions of management.

15.3 Identify the problems of business management.

16. UNDERSTAND ADVERTISEMENT.

16.1 Explain the concept of advertisement.

16.2 Enlist benefits and drawbacks of advertisement.

16.3 Describe principal media of advertisement used in business world.

17. UNDERSTAND THE ECONOMIC PROBLEMS OF PAKISTAN.

17.1 Describe economy of Pakistan.

17.2 Explain economic problems of Pakistan

17.3 Explain remedial measures for economic problems of Pakistan.

ET-203: D.C. MACHINES AND BATTERIES.

Total Contact Hours:

Theory:	64	T	P	C
Practical:	96	2	3	3

AIM To enable students understand basic principles, construction, working and control techniques of DC machines. Also understand types, working and charging of secondary cells/batteries.

- 1. D.C. MACHINES FUNDAMENTALS 6 Hrs.**
 - 1.1 Review of Electromagnetic quantities, Faraday's Laws of Electromagnetic Induction, Linked Flux, Flemings right & left hand rules, Lenz's Law, and force on a current carrying conductor.
 - 1.2 Parts of D.C Machines, body, yoke, field, poles, armature, commutator, etc.
 - 1.3 Armature winding, single layer, double layer, simplex, duplex, lap and wave.

- 2. D.C MACHINE AS D.C. GENERATOR 20 Hrs.**
 - 2.1 Principle of working of elementary D.C generator.
 - 2.2 E.M.F equation of D.C generator and problem solving.
 - 2.3 Types of Generator, separately excited, self-excited, shunt, series and compound.
 - 2.4 No load characteristics of separately and self-excited shunt generator, critical resistance solving problems.
 - 2.5 On load, internal, external characteristics & problem solving of generators voltage regulation, method of compounding, degree of compounding.
 - 2.6 Armature reaction & commutation.
 - 2.7 Interpoles or composites.
 - 2.8 Power stages, losses and efficiency, condition for maximum efficiency.
 - 2.9 Parallel operation of shunt & compound generator, load sharing.
 - 2.10 Safety and protection while working on generators

- 3. D.C. MACHINES AS D.C. MOTOR 26 Hrs.**
 - 3.1 Principle & working of elementary D.C motor.
 - 3.2 Back e.m.f and torque development in D.C motors, torque equation.
 - 3.3 Electrical, Mechanical, V/I_a characteristics of series, shunt, compound (Differential) motors.
 - 3.4 Comparison of D.C motors, and their applications and introduction to Brush Less Direct Current (BLDC machines)
 - 3.5 Power stages, losses, BHP and efficiency of D.C. motors.
 - 3.6 Speed control of D.C motor by changing field flux, armature current and voltage.
 - 3.7 Merits and demerits of different speed controlling methods.
 - 3.8 Necessity and Design of Motor Starter, 3 & 4 points starter.
 - 3.9 Controllers, manual, automatic magnetic, semi-automatic.

- 3.10 Testing of D.C machines, Dynamometer, Hopkinson tests.
- 3.11 Safety and protection while working on motors.

4. BATTERIES

12 Hrs.

- 4.1 Galvanic Cell, Primary cells, types, construction, dry cell.
- 4.2 Secondary cells, storage cells.
- 4.3 Types of storage cells, Lead Acid, Nickel iron, Nickel Cadmium, Lithium-Ion.
- 4.4 Chemical action during charging and discharging of Lead Acid battery.
- 4.5 Construction and working of Lead Acid battery.
- 4.6 Preparation of electrolytes of given specific gravity.
- 4.7 Variation in specific gravity during charging & discharging.
- 4.8 Effect of specific gravity on e.m.f.
- 4.9 Construction & working of Lithium-Ion cell and role of BMS.
- 4.10 Construction & working of Nickel-Cadmium Cell.
- 4.11 Safety in handling of batteries, preparation of electrolytes and handling acids.
- 4.12 Safe disposal of chemicals

ET-203: D.C. MACHINES & BATTERIES

INSTRUCTIONAL OBJECTIVES

1. UNDERSTAND THE FUNDAMENTALS OF D.C. MACHINES

- 1.1. State Faraday's Laws of Electromagnetic induction
- 1.2. Derive $e=Ldi/dt$ equation and describe linked flux.
- 1.3. State Fleming's right hand rule.
- 1.4. State Lenz's Law.
- 1.5. Explain force developed on a current carrying conductor lying in magnetic field.
- 1.6. State parts of D.C. machine, body, yoke, field poles and winding, commutators, armature
- 1.7. Draw Armature winding, lap, wave, single layer, double layer, simplex and duplex.
- 1.8. Calculate and develop given armature winding for lap & wave duplex winding.

2. UNDERSTAND THE WORKING OF D.C. MACHINES AS D.C. GENERATORS

- 2.1. Explain principle of single loop D.C. generator.
- 2.2. Derive EMF equation of a D.C. generator and solve related problems.
- 2.3. List types of D.C. generator depending upon excitation (self and separately excited).
- 2.4. List types of D.C. generator showing their connections (Shunt, series, compound).
- 2.5. Draw no load characteristics of separately and self-excited shunt generators.
- 2.6. Evaluate critical resistance from O.C.C for a given machine.
- 2.7. Solve problems relating to o.c.c critical resistance, emf and speed.
- 2.8. Draw on-load internal, external characteristics for series, shunt and compound generators.
- 2.9. Solve problems relating to load characteristics.
- 2.10. State levels of compounding of compound generator, as under & over compounding.
- 2.11. Explain armature reaction.
- 2.12. Define commutation.
- 2.13. Explain purpose of Inter-poles
- 2.14. Express power stages in D.C. generators and its efficiency.
- 2.15. Solve problems on power stages and efficiency of D.C. generator.
- 2.16. State conditions for maximum efficiency of a D.C. generator.
- 2.17. Solve problems on efficiency of D.C. generator.
- 2.18. Explain parallel operation of series shunt and compound generators.

3. UNDERSTAND CONSTRUCTION, TYPES AND USES OF D.C MOTORS

- 3.1. Explain working principle of an elementary D.C. motor.
- 3.2. State back e.m.f produced in motor armature.
- 3.3. Explain development of torque due to back e.m.f.
- 3.4. Derive motor torque equation.
- 3.5. Draw electrical, mechanical, V/I_a characteristics of series, shunt and compound (Differential/cumulative) motors.
- 3.6. Classify dc motors (Series, shunt, compound) and introduce BLDC motors

- 3.7 State application of motors depending upon their characteristics.
- 3.8 Explain power stages in D.C. motors, BHP, losses, efficiency.
- 3.9 Solve problems on power stages of DC motors.
- 3.10 Describe speed control of dc motors, by changing field flux, armature current and voltage.
- 3.11 Compare different speed control methods
- 3.12 Explain controllers, manual, automatic and semi-automatic.
- 3.13 Describe importance of testing of dc machines.
- 3.14 Explain dynamometer, Hopkinson & Swinburn tests.
- 3.15 Explain the difference between ac circuit breakers and dc circuit breakers for safety and protection.

4. UNDERSTAND CONSTRUCTION, TYPES AND CHARGING OF BATTERIES

- 4.1 Define primary cell.
- 4.2 State type of cells
- 4.3 Describe working of primary cells.
- 4.4 State uses of Dry cell
- 4.5 Explain working of dry cell.
- 4.6 Explain the working of secondary cell and battery (Storage cell, accumulator, lead acid, and alkaline).
- 4.7 Explain the need, energy density and power density of Super Capacitors.
- 4.8 Sketch construction of lead acid battery.
- 4.9 Discuss chemical process in lead acid battery on charging and discharging.
- 4.10 State method of preparation of electrolyte for a given specific gravity.
- 4.11 State the effects of charging and discharging on the specific gravity of the electrolyte.
- 4.12 Draw sketch of Lithium-Ion cell. NMC for Electric Vehicles and LFP for backup storage.
- 4.13 Describe working of Lithium-Ion battery and the need of battery management system (BMS).
- 4.14 Draw sketch of Nickel Cadmium battery.

ET-203: D.C. MACHINES AND BATTERIES

LIST OF PRACTICALS:

Note: Students should demonstrate concern for personal and equipment safety while working in Lab.

1. Study of constructional features of D.C machine.
2. Identification of terminals, polarity, determination of resistance of field and armature windings.
3. Developing Lap winding diagram for a given armature.
4. Develop wave winding diagram for a given armature.
5. Calculating winding factor and develop winding diagram lap and wave for a given armature.
6. Rewinding an armature, session I.
7. Rewinding armature, session II.
8. Rewinding armature, session III (last).
9. Connecting and operating D.C machine as separately excited generator and to plot its O.C.C.
10. Connecting and operating D.C machine as self-excited shunt generator and to plot its O.C.C. and to find critical resistance.
11. Operate a series generator and draw its external characteristics.
12. Operate a shunt generator and draw its external characteristics.
13. Plot external characteristics of compound generator for level, under and over compounding.
14. Parallel operation of two shunt generators.
15. Determination of copper, iron & friction losses by actual loading.
16. Study of starting and controlling equipment.
17. Connecting starter and controlling circuit with a shunt motor.
18. Connecting a machine as series motor (operation of fractional H.P series motor).
19. Determination of motor efficiency by direct loading.
20. Experimentally plot speed-torque characteristics of a shunt motor.
21. Plotting speed-current characteristics from data of a shunt motor.
22. Plotting Torque-current characteristics from experimental data of a shunt motor.
23. Plot torque-current characteristic of a series motor from experimental data.
24. Draw speed-torque characteristics of a series motor from experimental data.
25. Plot speed-current characteristic of compounded motor.
26. Draw Torque-current characteristics of compound motor.
27. Controlling speed of a shunt motor by changing field current & armature current.
28. Controlling speed of a series motor by armature and field diverter.
29. Determination of B.H.P of motor by brake test.
30. Determination of efficiency of motor by Swinburn test.
31. Determination of torque and efficiency by dynamo meter.
32. Regenerative or Hopkinsons test.
33. Study constructional features of lead acid battery and Lithium-Ion battery of a laptop with its BMS.
34. Preparation of electrolyte (H_2SO_4) of a given specific gravity and charging lead acid battery.

** Students must prepare practical journal and get it checked weekly by the concerned teacher. He should produce it to external examiner for sessional work/marking check up at the time of final examination.

TEXT/REFERENCE BOOKS

1. A Course in Electrical Engineering Vol.I By Dawes, L. Chester.
2. Audel's Electric Motor guide.
3. Electric Machinery Fundamentals by "Stephen. J.Chappman"
4. A Text Book of Electrical Technology by B.L. Theraja.
5. D.C Machines by Audel's.
6. Direct Current Motors & Generators by M.C. Mongal-Keth-Rouson.

ET-273: ELECTRICAL INSTRUMENTS AND MEASUREMENTS

Total Contact Hours:

Theory:	64	T	P	C
Practical:	96	2	3	3

AIM: To enable students understand fundamental forces acting in electrical measuring instruments, and the construction, working & applications of the whole range of measuring instruments. This range includes special purpose and electronic instruments. This course also provides information on measuring bridges in common use.

A: BASICS OF MEASURING INSTRUMENTS

6 Hrs.

1. CLASSIFICATION OF INSTRUMENTS

- 1.1. Absolute instruments.
- 1.2. Secondary instruments.
- 1.3. Indicating instruments.
- 1.4. Recording instruments.
- 1.5. Integrating instruments.
- 1.6. Digital instruments.
- 1.7. Analog instruments.

2. EFFECTS OF ELECTRIC CURRENT UTILIZED IN MEASURING INSTRUMENTS

- 2.1. Magnetic effect.
- 2.2. Heating effect
- 2.3. Chemical effect.
- 2.4. Electrostatic effect.
- 2.5. Electromagnetic effect.

3. FORCES ACTING IN AN INSTRUMENT

- 3.1. Deflecting force.
- 3.2. Controlling force and its types.
- 3.3. Damping force and its types.

4. TANGENT GALVANOMETER

- 4.1. Theory and working of Tangent galvanometer.
- 4.2. Parts of tangent galvanometer.

5. DISTINCTION BETWEEN INDICATING AND RECORDING INSTRUMENT

- 5.1. Construction and working distinction /difference.

B: CONSTRUCTIONAL FEATURES OF MEASURING INSTRUMENTS

6 Hrs.

6. BALANCING OF MOVING PARTS

- 6.1 Torque /weight ratio
- 6.2 Balancing weights.

7. CONSTRUCTIONAL FEATURES OF INDICATING INSTRUMENTS

- 7.1 Types of instrument scales.
- 7.2 Reading of scales.
- 7.3 Types of Pointers.
- 7.4 Types of springs and materials.
- 7.5 Methods of supporting of moving system of instruments.
- 7.6 Types of casings of measuring instruments and materials.

C: AMMETERS AND VOLT METERS

12 Hrs.

8. PERMANENT MAGNET MOVING COIL INSTRUMENT

- 8.1 Working Principle and working method.
- 8.2 Construction.
- 8.3 Application.

9. MOVING COIL DYNAMOMETER INSTRUMENT

- 9.1 Working Principles and working method.
- 9.2 Construction and applications.
- 9.3 Connections as Am-meter, Voltmeter and Wattmeter.
- 9.4 Errors and their remedies.
- 9.5 Advantages and disadvantages over other types.

10. SHUNTS AND MULTIPLIERS

- 10.1 Definition/Purpose of shunts and multipliers.
- 10.2 Simple Calculation for range extension of am-meters and voltmeters.
- 10.3 Construction and materials used for shunts and multipliers.

11. MOVING IRON TYPE INSTRUMENTS

- 11.1 Types of Moving iron instruments
- 11.2 Working principle and working.
- 11.3 Construction
- 11.4 Application

12. ERRORS IN AM-METERS AND VOLTMETERS AND CALIBRATION

- 12.1 Causes of errors.

- 12.2 Removing of errors.
- 12.3 Calibration of instruments.

13. BI METALLIC TYPE INSTRUMENT

- 13.1 Working principle and working..
- 13.2 Construction
- 13.3 Application.

14. THERMOCOUPLE TYPE INSTRUMENT

- 14.1 Types of Thermocouples.
- 14.2 Working principle and working.
- 14.3 Construction and application.

15. SHADED POLE TYPE INSTRUMENT

- 15.1 Working Principle and working.
- 15.2 Construction.
- 15.3 Application.

D: RESISTANCE MEASUREMENT & RESISTANCE MEASURING DEVICES

8Hrs.

16. CLASSIFICATION OF RESISTANCES

- 16.1 Classification of resistances from measurement point of view.
- 16.2 Introduction to resistance measuring instruments and bridges

17. OHM METER

- 17.1 Types and working Principle of both types (series, parallel).
- 17.2 Construction and application of both (series, parallel) types.
- 17.3 Scale reading of an ohm meter

18. A.V.O. / MULTI-METER

- 18.1 Working principle and construction.
- 18.2 Scale reading.
- 18.3 Applications.

19. INSULATION RESISTANCE TESTER (MEGGER)

- 19.1 Working principle and construction.
- 19.3 Applications.

20. EARTH RESISTANCE TESTER

- 20.1 Working principle and Constructions.
- 20.2 Applications and method of use.

21. RESISTANCE MEASURING BRIDGES (WHEAT STONE & KELVIN'S DOUBLE BRIDGE)

- 21.1 Working Principle and construction.
- 21.2 Uses.

22. MURRAY LOOP TEST

- 22.1 Working Principle.
- 22.2 Applications.

E: ENERGY MEASUREMENT

6 Hrs.

23. ENERGY METER SINGLE PHASE

- 23.1 Energy, energy meters and types.
- 23.2 Working Principle and Construction of single phase Energy meter (induction type).
- 23.3 Types of scales in use and reading the scale.
- 23.4 Errors in energy meter and energy meter tests.
- 23.5 Calibration of Energy meter.

24. THREE PHASE ENERGY METER

- 24.1 Working Principle and construction of 3. Phase (induction type) energy meter.
- 24.2 Scale reading.
- 24.3 MDI meter and its scale reading.

F: SPECIAL INSTRUMENTS

8Hrs.

25. INSTRUMENT TRANSFORMERS

- 25.1 Types (C.T & P.T).
- 25.2 Advantages over shunts and multipliers.
- 25.3 Working principle, working and construction of CT & PT.
- 25.4 Standard ratios, ratings and burden of CT.
- 25.5 Standard ratios and ratings of PT.
- 25.6 Vector diagram, Phase angle, errors and reducing of errors of CT & PT.

26. POWER FACTOR METERS AND FREQUENCY METERS

- 26.1 Types according to supply and construction.
- 26.2 Working principle of each

27. SYNCHRONOSCOPES

- 27.1 Introduction and types.
- 27.2 Construction and working of dynamometer and moving iron type Synchrosopes.
- 27.3 Uses.

G: MEASUREMENT OF NON- ELECTRICAL QUANTITIES

6 Hrs.

(Temperature, Light and RPM)

28. TEMPERATURE MEASUREMENT DEVICES

- 28.1 Types of Pyrometers (resistance, thermocouple, Radiation).
- 28.2 Working principle and working of each type.
- 28.3 Application of each type.

29. LUX METERS

- 29.1 Types.
- 29.2 Working principle.
- 29.3 Applications.

30. TACHOMETERS

- 30.1 Types (Mechanical-Electrical & Electronic).
- 30.2 Construction and working of mechanical counters.
- 30.3 Construction and working of generator and photo pickup type electronics tachometers.

H: ELECTRONICS INSTRUMENTS

6 Hrs.

31. OSCILLOSCOPE

- 31.1 Types and applications of oscilloscopes.
- 31.2 Construction and working of single beam oscilloscope.
- 31.3 Measurement of AC, DC voltage, AC, DC current and frequency

32. SIGNAL GENERATORS AND MEASUREMENT OF CAPACITANCE & INDUCTANCE

- 32.1 Types (AF & RF)
- 32.2 Working Principle of both types.
- 32.3 Construction.
- 32.4 Applications.
- 32.5 Measuring Inductance with the help of Signal Generator.
- 32.6 Measuring Capacitance with the help of Signal Generator.

I: DIGITAL INSTRUMENTS

6 Hrs.

33. DIGITAL METERS

- 33.1 Introduction to digital instruments and advantages over analogue instruments
- 33.2 Types (commonly used am-meter, voltmeter, ohmmeter, multi-meter, frequency meter and energy meter).
- 33.3 Explanation of working of each digital instrument with the aid of block diagram.
- 33.4 Error and their reasons.

INSTRUCTIONAL OBJECTIVES

- 1. UNDERSTAND THE DIFFERENCE BETWEEN PRIMARY AND SECONDARY INSTRUMENTS WITH FURTHER CATEGORIES OF SECONDARY INSTRUMENTS**
 - 1.1 Define absolute and secondary instruments. Give examples of each
 - 1.2 Describe difference between absolute and secondary instruments.
 - 1.3 State difference among indicating, recording and integrating instruments.
 - 1.4 State difference between analog and digital instruments.
 - 1.5 Describe applications of each type.

- 2. UNDERSTAND THE EFFECTS OF ELECTRIC CURRENT USED IN MEASURING INSTRUMENTS.**
 - 2.1 Explain the magnetic effect and its use in measuring instruments
 - 2.2 Explain the heating effect and its use in measuring instruments
 - 2.3 Define the chemical effect and its use in measuring instruments
 - 2.4 Explain electrostatic effect and its use in measuring instruments
 - 2.5 Explain electromagnetic effect, its elements. (Amp-Turn) and its use in measuring instruments

- 3. UNDERSTAND VARIOUS FORCES ACTING IN INDICATING INSTRUMENTS**
 - 3.1 Explain deflecting force and the methods of providing it in instruments.
 - 3.2 Derive formula of deflecting force for permanent magnet moving coil instrument.
 - 3.3 Explain controlling force; explain its types and the methods of providing it in instruments.
 - 3.4 Explain damping force, explain its types (air, oil & eddy current) and levels (under, normal & critical damping.) used in instruments.
 - 3.5 Compare each method of damping (advantages and disadvantages).

- 4. KNOW THE WORKING OF TANGENT GALVANOMETER**
 - 4.1 Explain the theory and working principle of Tangent Galvanometer.
 - 4.2 Describe constructional features of Tangent Galvanometer.
 - 4.3 Describe its adjustments before use.
 - 4.4 Describe its use for finding current and earth's magnetic field.

- 5. UNDERSTAND THE DIFFERENCE BETWEEN INDICATING AND RECORDING INSTRUMENTS**
 - 5.1 Explain the construction and use of indicating instrument.
 - 5.2 Explain the use of recording instruments.
 - 5.3 Write advantages of recording instruments over indicating instruments.

- 6. UNDERSTAND PURPOSE AND TECHNIQUES OF BALANCING OF MOVING PARTS**

- 6.1 Explain the effect of unbalancing & balancing of moving parts of instruments.
- 6.2 Explain types of weights used in indicating instruments and their position.

7. UNDERSTAND THE CONSTRUCTIONAL FEATURES OF INSTRUMENTS

- 7.1 State types of meter scales (linear and non linear, single range and multi range, simple and mirror scales).
- 7.2 Explain the parallax and its effect on reading and method of reducing parallax error in portable and panel type instruments.
- 7.3 State precautions for reading of analog scales.
- 7.4 Explain why some scales are non uniform.
- 7.5 State types of control springs; describe their characteristics and state materials used for control springs.
- 7.6 Explain types of pointers used in indicating instruments.
- 7.7 Enlist material used for instrument pointers.
- 7.8 Explain the care required in handling the pointers.
- 7.9 Explain different methods of supporting the moving system of instruments.
- 7.10 Describe types of casings of measuring instruments and materials.

8. UNDERSTAND WORKING OF PERMANENT MAGNET MOVING COIL INSTRUMENT

- 8.1 Explain the working principle and working method.
- 8.2 Explain the parts and their role in such instruments.
- 8.3 Draw sketches of each part.
- 8.4 Explain difference in winding and sensitivity when used as am-meter, volt meter and Ohm-meter.

9. UNDERSTAND VARIOUS KINDS OF DYNAMOMETER TYPE INSTRUMENTS

- 9.1 Explain the working principle and working method.
- 9.2 Explain Construction and applications.
- 9.3 Draw sketches and explain connection as am meter, as voltmeter and as wattmeter.
- 9.4 Enlist merits and demerits of dynamometer type instruments over other types.
- 9.4 Explain errors and their remedies.

10. DESIGN SHUNTS AND MULTIPLIERS FOR RANGE EXTENSION OF AMMETERS AND VOLTMETERS.

- 10.1 Explain purpose of shunt and multiplier.
- 10.2 Explain materials used and reasons.
- 10.3 Calculate value for shunt and multiplier for given meter's range extension.
- 10.4 Describe physical design, power rating of shunt and multiplier.

11. UNDERSTAND THE WORKING PRINCIPLE, PARTS AND USES OF MOVING IRON TYPE INSTRUMENTS

- 11.1 Explain the working principle of both types (attraction and repulsion).
 - 11.2 Draw sketches to show the assembly.
 - 11.3 Explain the applications of such instruments.
 - 11.4 State names of parts.
- 12. UNDERSTAND ERRORS IN AM-METERS AND VOLTMETERS AND CALIBRATION**
- 12.1 Enlist common errors of am-meter and voltmeters
 - 12.2 Describe causes of errors and methods of removing/reducing these errors.
 - 12.3 Define instrument calibration.
 - 12.4 Describe methods of calibration of instruments.
- 13. UNDERSTAND BI-METALLIC INSTRUMENTS**
- 13.1 Describe working principle and working method of Bi-metallic instruments.
 - 13.2 State materials used.
 - 13.2 State the applications of such instruments.
- 14. UNDERSTAND THERMOCOUPLE TYPES OF INSTRUMENTS**
- 14.1 Define thermocouple and Thermocouple instruments.
 - 14.2 Explain the working principle of thermocouple type instruments.
 - 14.3 Draw sketch of thermocouple type instruments.
 - 14.4 State various materials used.
 - 14.5 State applications of thermocouple type instruments.
- 15. UNDERSTAND SHADED POLE TYPE INSTRUMENTS**
- 15.1 Explain the working principle
 - 15.2 State application.
 - 15.3 Name parts of the instrument
 - 15.4 Draw sketch.
 - 15.5 State the merits & demerits of such instruments.
- 16. CLASSIFY OF RESISTANCES & INTRODUCTION OF RESISTANCE MEASURING DEVICES**
- 16.1 Classify resistances from measurement point of view.
 - 16.2 Describe resistance measuring instruments and bridges
- 17. UNDERSTAND OHM METERS**
- 17.1 Explain the working principle of Analog Ohm meter.
 - 17.2 Explain scale reading on different range settings.
 - 17.3 State precautions of using ohm meters.
- 18. UNDERSTAND THE WORKING AND USES OF AVO / MULTI-METER**
- 18.1 State kinds of multi-meters (analog, digital).

- 18.2 Explain Working principle of analog multi-meter with simple diagram.
- 18.3 State scale reading techniques on different quantities and range settings.
- 18.4 Explain use as ohm meter on live circuits as am-meter and voltmeter.

19. UNDERSTAND THE WORKING & USE OF MEGGER

- 19.1 Explain working principle of Megger.
- 19.2 Explain operation for continuity, short circuit and open circuit tests.
- 19.3 Explain scale reading
- 19.4 Draw sketch, naming each part.

20. UNDERSTAND WORKING AND USE OF EARTH RESISTANCE TESTER

- 20.1 State the working principle of earth tester and its application.
- 20.2 Explain the method of use of earth tester for finding the earth resistance of an earth.
- 20.3 Draw sketch

21. UNDERSTAND PRINCIPLE OF RESISTANCE MEASURING BRIDGES AND THEIR APPLICATION

- 21.1 Explain working principle of wheat stone bridge with diagram.
- 21.2 Calculate unknown resistance using wheat stone bridge.
- 21.3 Explain its construction and use.
- 21.4 Explain working principle of Kelvin's double bridge.
- 21.5 Explain construction and use.
- 21.6 Calculate resistance value using Kelvin's Bridge.

22. UNDERSTAND MURRAY LOOP TEST AND ITS APPLICATION

- 22.1 Explain working principle of Murray loop test.
- 22.2 Explain its use for underground cables.
- 22.3 Calculate fault distance using loop test.

23. UNDERSTAND WORKING AND USE OF SINGLE PHASE INDUCTION TYPE ENERGY METER

- 23.1 Explain the working principle of single phase Energy meter (induction type).
- 23.2 Draw sketch showing assembly
- 23.3 Enlist name of the parts and describe function of each part.
- 23.4 Explain scale reading.
- 23.5 Enlist errors and their causes.
- 23.6 Explain calibration techniques of single phase energy meter.

24. UNDERSTAND WORKING AND USE OF THREE PHASE ENERGY METERS

- 24.1 Explain types of 3. Phase (induction type) energy meter, their construction and working
- 24.2 Enlist parts and describe function of each part
- 24.3 Explain MDI meter and its scale reading.

25. UNDERSTAND WORKING PRINCIPLE OF INSTRUMENT TRANSFORMERS

- 25.1 Define instrument transformer, Current transformer & potential transformer.
- 25.2 Explain construction and working principle of C.T & P.T with vector diagram
- 25.3 Describe application of C.T & P.T's.
- 25.4 Explain standard ratios, current ratings and burden of CT.
- 25.5 Enlist possible errors and their remedies of CT and PT.
- 25.6 Explain personal and instrument safety while using CT.
- 25.7 Standard voltage ratings of PT.
- 25.8 Explain effect of burden and frequency on C.T & P.T

26. UNDERSTAND POWER FACTOR METERS AND FREQUENCY METERS

- 26.1 State types of P.F meters with respect of supply (Single and three phase)
- 26.2 State types of P.F meter with respect to construction (Dynamometer, moving iron).
- 26.3 Explain working principle of each type of P.F meter.
- 26.4 Draw circuit diagram.
- 26.5 Enlist types of frequency meters.
- 26.6 Explain working principle and working of electrical and mechanical resonance type frequency meters.
- 26.7 Explain principle of Weston type.

27. UNDERSTAND WORKING AND APPLICATION OF SYNCHRONOSCOPE

- 27.1 State types of synchronoscope.
- 27.2 State working principle and construction of each.

28. UNDERSTAND TYPES OF TEMPERATURE MEASURING DEVICES

- 28.1 Enlist types of temperature measuring devices. Explain working of resistance type device
- 28.2 Explain principle and working of resistance, thermocouple and radiation pyrometers.
- 28.3 Explain particular application of each.

29. UNDERSTAND WORKING OF LUX METER

- 29.1 Define Lux meter/light meter
- 29.2 Enlist all types of Lux meters (Optical, Physical and radiation type).
- 29.3 Describe working principle and construction of photo voltaic type Lux meter.

30. KNOW WORKING PRINCIPLE OF SPEED/R.P.M MEASURING INSTRUMENTS

- 30.1 Enlist types of tachometers (Mechanical, electrical and electronics)
- 30.2 Describe working principle and working of RPM/speed counter (Mechanical)
- 30.3 Describe working principle and working of generator type tachometers
- 30.4 Describe working principle and working of electronic (photo pick up type) tachometer/counter.
- 30.5 State method of use of each tachometer.

31. UNDERSTAND WORKING PRINCIPLE OF OSCILLOSCOPE

- 31.1 Enlist types of oscilloscopes with application of each oscilloscope.
- 31.2 Describe apparent construction and controls of an oscilloscope.

- 31.3 Enlist parts of CRO and describe function of each part of Cathode Ray Oscilloscope.
- 31.4 Explain working of an oscilloscope.
- 31.5 Explain method of measuring AC and DC voltage with an Oscilloscope.
- 31.6 Explain method of displaying wave shape of AC supply and measuring frequency with an Oscilloscope.

32. KNOW WORKING OF SIGNAL GENERATOR

- 32.1 State types of signal generators (AF & RF).
- 32.2 Describe working Principle, construction and uses of both types
- 32.3 Measuring Inductance with the help of Signal Generator.
- 32.4 Measuring Capacitance with the help of Signal Generator.

33. UNDERSTAND PRINCIPLE, TYPES AND USES OF DIGITAL INSTRUMENTS

- 33.1 Enlist common types used in electrical labs (am-meter, voltmeter, ohmmeter, multi-meter, frequency meter and energy meter)
- 33.2 Enlist possible errors with reasons of digital instruments.
- 33.3 Explain working principle of each with the help of block diagram.

LIST OF PRACTICALS

Note: The students should show concern for personal and equipment safety while working in Lab. Also show safe handling of instruments.

1. Demonstration of Absolute & Secondary instruments.
2. Study of constructional features of tangent galvanometer and its use for finding current.
3. Comparative study of indicating, integrating & recording instruments.
4. Study of methods of damping forces (Air friction, fluid friction, and eddy current) in instruments.
5. Making sketches of different types of pointers fitted on shafts with weight.
6. Study of control springs, and their tension/position adjustment.
7. Dismantling and assembling of permanent magnet instrument and making sketch.
8. Study of dynamometer type instrument parts and making their sketch.
9. Study of shunts and multipliers and making their sketches
10. Dismantling and assembling of moving iron instruments (repulsion and attraction type) and making sketch.
11. Study of bi metallic type instruments and making their sketch
11. Study of Thermocouple, their variety and shapes used in measuring instruments.
12. Study of thermistors used for control of current.
13. Demonstration of shaded pole type instruments and sketch the parts and assembly.
14. Study of wattmeter, making sketch and use for the measurement of power of a lamp.
15. Study of ohm-meter and its scale and practice of using it for resistance measurement of different appliances.
16. Study of AVO meter (analog type), its scale reading practice and use as Voltmeter and Ammeter.
17. Practice the use of analog & digital multi-meter for low and high resistance measurement.
18. Study of Insulation resistance tester/Megger and practice of its use for continuity, short circuit and insulation testing of a motor.
19. Using an earth resistance tester for finding earth resistance.
20. Study of single and three phase analog and digital energy meters and their connections.
21. Visit of substation to study C.T. & P.T and their use with measuring instruments & relays on substation.
22. Study of P.F. meter and finding power factor of all kinds of loads (Resistive, Inductive Capacitive, and Mixed).
23. Study the types of frequency meters and measurements of frequency of AC supply.
24. Use of wheat stone bridge for resistance measurement.
25. Connecting power factor meter for measuring P.F of an unbalanced 3-phase load.
26. Study of synchroscope and practice of using for parallel operation of alternators.
27. Study of various pyrometers and their use in measuring instruments.

28. Study and use of LUX METER for measuring light level of a class room and veranda.
29. Use of tachometer to measure the rotational speed of a motor.
30. Use of C.R.O for displaying & measuring of Electrical quantities (AC, DC voltage, current and frequency).
31. Study of M.D.I meter and method of taking its reading.
32. Measurement of capacitance & inductance with LCR meter.

Note: * Industrial visits for this course are recommended.
** Students must prepare theory and practical note books and get it checked weekly by the concerned teacher. They should produce these to external examiner for sessional work/marking check up at the time of final exam.

RECOMMENDED BOOKS

1. Testing Instruments by Audel's.
2. Electrical Instruments & Measurement by E.W. Golding.
3. Electronic Measuring Instruments by G.D. Link.
5. Electrical Instruments and Measurements by Afzal Bashir & Khalid Mehmood
5. Industrial Electrical Measurement & Instruments by Kenelm Edgeumbe.
6. Fundamentals of Electrical Measurements by C.T. Baldwin.
7. A Text Book of Electrical Engineering by S.L. Uppal.
8. Electronics for Today & Tomorrow. by Tom Duncan.
10. An introduction to Electrical Instrumentation by B.A. GREGORY

ET- 253

UTILIZATION OF ELECTRICAL ENERGY

Total Contact Hours:

Theory:	64	T	P	C
Practical:	96	2	3	3

AIM Electrical Energy is used in Industry for various job and operations including Illumination, Electroplating, Heating and Ventilation and Locomotives etc. This course will give an understanding of the principles and practices related to efficient and safe industrial use of electrical energy in some of the selected fields.

COURSE CONTENTS

- 1 ILLUMINATION. 18 Hrs.**
- 1.1 Modern theory of light and radiation from hot body.
 - 1.2 Terms; black-body: like hot body, solid angle,
 - 1.3 Law's of illumination: inverse square law, Lambert's cosine law.
 - 1.4 Depreciation factor, utilization factor, waste light factor.
 - 1.5 Lighting scheme and its design.
 - 1.6 Lamps, shades and reflectors.
 - 1.7 Flood lighting and its purpose and arrangements.
 - 1.8 Sources of light (Natural and artificial).
 - 1.9 Incandescent lamps, gas filled, clear and frosted glass lamps.
 - 1.10 Discharge lamps, sodium vapour, high pressure mercury vapour.
 - 1.11 Fluorescent lamps, stroboscopic effect.
 - 1.12 Light Emitting Diode (LED) lamps, Need for driver circuit.
 - 1.13 Power quality, harmonics, distortion power and power factor for LED and fluorescent lamps
- 2 ELECTRO PLATING. 10 Hrs.**
- 2.1 Fundamental principles of chemistry and metallurgy relating to electroplating.
 - 2.2 Introduction to electro plating.
 - 2.3 Properties of metals, acids, alkalies and neutralization.
 - 2.4 Faraday's law of Electrolysis.
 - 2.5 Electrolytic cell, Electrodes, electrolytes and polarization.
 - 2.6 Acid used in electroplating H_2SO_4 , HNO_3 , HCL, aqua-regia (Nitro-Hydrochloric acid).
 - 2.7 Salts used in electroplating.
 - 2.8 Alkalies used in electroplating.
 - 2.9 Electroplating plants, electroplating tank, Electrical supply system.
 - 2.10 Rheostatic and active current control in electroplating.
 - 2.11 Electroplating process.
 - 2.12 Cleaning of objects mechanically and chemically.

- 2.13 Copper and silver plating.
- 2.14 Current densities for various thicknesses and materials of jobs.
- 2.15 Planning of electroplating shop.

3 REFRIGERATION. 10 Hrs.

- 3.1 Introduction to refrigeration and air conditioning.
- 3.2 Types of refrigeration and refrigerants.
- 3.3 Refrigeration process / cycle.
- 3.4 Refrigeration components (Evaporator, compressor, condenser etc.)
- 3.5 Electrical accessories and circuits of a refrigerator.
- 3.6 Introduction to air conditioning.
- 3.7 Types of domestic air conditioners and their capacities: window, split, dc-Inverter.
- 3.8 Electrical accessories and circuit for air conditioner.
- 3.9 Introduction to commercial air-conditioning (chiller plants and central air-conditioning system)

4 ELECTRIC TRACTION. 16 Hrs.

- 4.1 Introduction to Electric Traction, its advantages and disadvantages.
- 4.2 Systems of electric traction (overhead wire & battery operated)
- 4.3 Motors used for electric traction (D.C, Single phase & 3-Phase Induction, BLDC, Switched Reluctance Motor (SRM).
- 4.4 Starting and speed control of traction motor, series parallel control.
- 4.5 Drum type controllers.
- 4.6 Field weakening and tapped field control.
- 4.7 Electric braking, plugging rheostat, regenerative.
- 4.8 Hybrid Electric Vehicle (HEV), Series HEV, Parallel HEV, Plug-In HEV (PHEV), All Electric Vehicles.
- 4.9 Construction and advantage of EVs over internal combustion engine (ICE) vehicles.
- 4.10 Role (not construction) of Variable Speed Drive (VSD) and Variable Frequency Drive (VFD)

5 ELECTRIC HEATING. 10 Hrs.

- 5.1 Introduction to Electric Heating, advantages and its application.
- 5.2 Types of electric heating, power frequency heating, high frequency heating.
- 5.3 Resistance heating and its types, Resistance furnaces.
- 5.4 Space heating using heat pumps, Reversible air-conditioners and use in HVAC systems
- 5.5 Arc heating and its types, Arc furnaces.
- 5.6 Induction heating and its types, induction furnaces.
- 5.7 Die electric heating.
- 5.8 Infra-red heating.
- 5.9 Eddy current heating.
- 5.10 Review of electric welding, spot welding.

INSTRUCTIONAL OBJECTIVES**1. APPLIES CONCEPTS OF ILLUMINATION TO SIMPLE LIGHTING DESIGNS**

- 1.1 Explain modern theory of light.
- 1.2 Define term, hot body, solid angle.
- 1.3 Define luminous flux, luminous intensity.
- 1.4 Define MSCP, MHSCP, lumen hour and candela
- 1.5 State law's of illumination, inverse square law, Lambert's cosine law.
- 1.6 Explain, Depreciation factor, utilization factor, height factor.
- 1.7 Identify qualities of good lighting scheme.
- 1.8 Design a given lighting scheme.
- 1.9 Give types of lamps & shades.
- 1.10 Explain polar curves for different type of reflectors.
- 1.11 Explain flood lighting.
- 1.12 Explain purposes of flood lighting.
- 1.13 Sketch diagram of lamps: incandescent, sodium and mercury vapour, fluorescent lamp, LED lamp.
- 1.14 Describe working of lamps: incandescent, sodium vapour, mercury vapour, fluorescent and LED
- 1.15 State stroboscopic effect.
- 1.16 Discuss importance of ballast, igniter and driver and issues related to power quality (power factor, current harmonics, distortion power and current crest factor)

2. UNDERSTAND ELECTROPLATING PROCESS AND PLANTS

- 2.1 State fundamental principles of chemistry and metallurgy relating to electroplating.
- 2.2 List properties of metals, acids, alkalies used in electroplating.
- 2.3 State Faraday's law of Electrolysis
- 2.4 Define neutralization
- 2.5 List types of electrolytes, electrodes.
- 2.6 Describe chemical equations used in electroplating process.
- 2.7 Define standard solution.
- 2.8 Enumerate acids used in electroplating, H_2SO_4 , HNO_3 , HCl
- 2.9 Enlist salts used in electroplating.
- 2.10 Name alkalies, caustic potash, caustic soda, mixed alkalies, alkali cyanide.
- 2.11 Sketch parts of electroplating plant.
- 2.12 State rheostatic and active current control in electroplating.
- 2.13 Explain electroplating process.
- 2.14 Give process of cleaning objects, mechanically, chemically.
- 2.15 Describe copper & silver plating.
- 2.16 Give solution addition agents.
- 2.17 Give current densities for various thicknesses and materials of jobs.
- 2.18 Plan electroplating shop.

3. UNDERSTAND COMPONENTS AND WORKING OF SIMPLE REFRIGERATION AND AIRCONDITIONING SYSTEMS

- 3.1 Define terms used in refrigeration and air-conditioning systems.
- 3.2 Describe mechanical cycle of refrigeration.
- 3.3 Name different refrigerants and its applications.
- 3.4 Enlist electrical accessories used in refrigeration system.
- 3.5 Draw electrical circuit diagram of a refrigerator.
- 3.6 Explain different components of a domestic refrigerator.
- 3.7 Explain types of air-conditioners. Window, split and dc-Inverter.
- 3.8 Draw electrical circuit diagrams of an air-conditioner: conventional and dc-inverter.

4. UNDERSTAND ELECTRIC TRACTION SYSTEMS AND THEIR CONTROL

- 4.1 Define electric traction.
- 4.2 List merits & demerits of electric traction.
- 4.3 Explain systems of electric traction.
- 4.4 Describe electrification systems of electric traction.
- 4.5 Name motors used for electric traction.
- 4.6 Enlist the characteristics of D.C. series motor due to which it is preferred for traction purposes.
- 4.7 Describe starting and speed control of traction motors (series, parallel control).
- 4.8 Describe bridge transition method of speed control.
- 4.9 Explain drum type controller.
- 4.10 Explain method of speed control by tapped field (field weakening).
- 4.11 Enlist A.C. motors used in traction including BLDC and Switched Reluctance Motor (SRM).
- 4.12 Define methods of braking: plugging rheostatic, regenerative braking.
- 4.13 Differentiate between HEV, PHEV and All Electric Vehicle (EV). Discuss Series and Parallel HEV.
- 4.14 Make block Diagram of types of EVs and advantage over ICE vehicles.
- 4.15 Describe role of VSD in dc motor drive and VFD in ac motor drive. Details of construction excluded.

5. UNDERSTAND ELECTRIC HEATING FURNACES

- 5.1 Describe Electric Heating.
- 5.2 List merits and demerits of Electric Heating.
- 5.3 Describe electric furnace (Resistance wire heating).
- 5.4 Describe Heat pumps for use in space heating. Reversible air-conditioners and HVAC systems
- 5.5 Define infrared (radiation) heater.
- 5.6 Describe induction furnace.
- 5.7 Describe high frequency eddy current heating and electrostatic heating.
- 5.8 Explain working of an arc furnace.
- 5.9 Describe spot welding.

LIST OF PRACTICALS

1. Verification of inverse square law.
2. Verification of Lambert's cosine law.
3. Study of various reflectors.
4. Design lighting scheme for a hall.
5. Sketch the various parts of incandescent and gas filled lamps.
6. Visit and preparing a report of electroplating plant. Compare accuracy, precision and power savings of active current control.
7. Design a flood lighting scheme for a cricket ground. Compare Energy saving with LED lights.
8. Study of various materials used in electroplating and preparation of job for electroplating.
9. Study of equipment used in electroplating shop planning of electroplating shop, according to sequence of process.
10. Electroplating of a prepared job.
11. Study of an air conditioner, its components and drawing electric circuit. Compare power usage of dc-Inverter AC.
12. Study of refrigerator and tracing its electric circuit.
13. Draw Block Diagram of HEV, PHEV & EV or Study of Electric Bike/ Rickshaw/ Car
14. Visit to an ice factory.
15. Designing and making a 1000 W electric heating element.
16. Study of an electric resistance heating furnace.
17. Study of an electric arc furnace.
18. Study of spot-welding unit.
19. Comparison of power and energy consumption of a dc-inverter ac with conventional ac including reversible mode operation.
20. Visit to a central air-conditioning plant.
21. Visit to a cold storage.

RECOMMENDED BOOKS

1. Utilization of electrical energy by Engr. Badshah Munir.
2. Electrical Power by Soni Gupta.
3. A Course in Electrical Engineering by Soni Gupta.
4. Illumination Engineering, by Boast.
5. Refrigeration & Air Conditioning Principles.
6. Electrical Power by S.L. Uppal.
7. Electrical and Hybrid Vehicles by Iqbal Husain

Total Contact Hours:

Theory:	32	T	P	C
Practical	96	1	3	2

AIM The course provides necessary skill in the designing and planning an electrical installation keeping in view the necessary rules and regulations. It also gives practice for preparing estimates of the installation project following standard practice.

COURSE CONTENTS

- 1. INSTALLATION: 10 Hrs.**
 - 1.1 **Electrical Installation and earthing system.**
 - 1.1.1 Short review of electrical installations.
 - 1.1.2 Review of rules and regulation pertaining to earthing.
 - 1.1.3 Designing of earthing system for industrial installation.
 - 1.2 **Service lines**, methods of installations of service lines for single storey, multi storey buildings and estimate of material required with proper specifications.
 - 1.3 **Sub stations**, types of substations with respect to service and construction
 - 1.4 Equipment used in 132/11 KV grid substation, their classifications and Name plate ratings of some major equipment like power transformers, circuit breakers. Isolators, lightning arrestors, CT, PT etc.
 - 1.5 **Signal communication circuits**, system used in industrial and commercial buildings, fire alarm, burglar alarm, smoke alarm, sprinklers, intercom, float switch and their applications.
- 2. PLANNING. 10 Hrs.**
 - 2.1 Planning and designing of an electrical installation, steps of planning, estimating of electrical installation for a residential building, determining number of light points, fan points and number of socket out lets.
 - 2.2 Determining number of sub circuits for residential installation, factors for selecting correct conductor size for final sub circuits, main and sub main cables.
 - 2.3 Planning an earthing system for an industrial installation.
- 3. ESTIMATING. 12 Hrs.**
 - 3.1 Importance of estimating, tools and stationery forms used for estimating.
 - 3.2 Cost estimate: labor cost, material cost, transport cost, factors affecting cost.
 - 3.3 Tables used in planning and estimating.
 - 3.4 Estimation of quantity of material required for residential and industrial wiring.
 - 3.5 Steps and factors to be considered in preparation of cost estimate.

INSTRUCTIONAL OBJECTIVES**1. UNDERSTAND THE ELECTRICAL INSTALLATIONS.**

- 1.1 Name types of domestic and power (industrial and commercial) wiring systems and their particular applications along with accessories used for each installation methods.
- 1.2 Design earthing systems for a given industrial building.
- 1.3 List types of service lines (over head and underground) for single storey/multi storey buildings.
 - 1.3.1 Describe method of installation of service lines (over head and underground) for single storey/multi storey buildings.
 - 1.3.2 Prepare list of equipment required for installing each type of service line.
- 1.4 Briefly describe types of substations with respect to service (step up SS, step down SS, primary grid SS, secondary grid SS, Distribution SS, frequency changing SS, power factor correcting SS industrial, mining SS and switching SS) and construction (indoor, outdoor, underground, pole mounted and foundation mounted).
- 1.5 List and classify the equipment used in 132/11KV substations and nameplate ratings of major equipment.
- 1.6 Draw circuit diagram for signal communication system in commercial and industrial buildings used for fire alarm.
- 1.7 Describe the working of sprinklers, fire alarm, smoke alarm, burglar alarm. circuits by drawing circuit diagrams.
- 1.8 Explain inter-com system, with and without secrecy.
- 1.9 Explain float switch and give its applications.

2. UNDERSTAND THE PLANNING OF ELECTRICAL INSTALLATIONS.

- 2.1 Define planning and describe its purpose.
- 2.2 Describe planning of electrical projects.
- 2.3 Enlist drawbacks of starting a project without planning.
- 2.4 List necessary steps to be considered for planning residential building.
- 2.5 Determine number of light points, fan points and socket out-lets required for a given residential building.
- 2.6 Determine number of sub circuits required for a given residential building, with respect to main circuit and sub main circuit.
- 2.7 Select proper size of cables and circuit breakers for given circuits (main, sub main and final Sub circuits).
- 2.8 Explain rules and regulation relating to earthing.
- 2.9 Design earthing system for a given industrial installations.
- 2.10 Prepare plan for a given industrial installation load, plan an electrical installation showing cable sizes, ratings of CB etc.

3. PREPARE ESTIMATES OF ELECTRICAL INSTALLATIONS.

- 3.1 Describe importance of estimating.
- 3.2 List tools required for electrical estimating.
- 3.3 Describe stationary forms required for estimating.
- 3.4 List factors involved in preparing total cost of electrical project. (Material cost, labour cost, transport cost, contingencies, over head charges, supervision charges and contractor profit).
- 3.5 Explain importance of tables, used for planning and estimating.
- 3.6 Estimate quantity of material required for a given residential plan for PVC channel (PVC duct) wiring.
- 3.7 Estimate quantity of material required for a given residential plan for PVC concealed conduit wiring.
- 3.8 Describe necessary steps for preparing a cost estimate.
- 3.9 Prepare a cost estimate for a given residential electrical installation according to the given schedule rate list. (Use standard format for preparing/presenting report of the estimates of the given installation).

LIST OF PRACTICALS

1. Prepare Drawing of standard symbols used for building lay out plan
2. Prepare drawing of a building plan for 3-bed room house.
3. Prepare drawing of a plan of 4 bed room house.
4. Prepare drawing of service connection diagram (for over head cable and bare conductors for low roof and high roof/multi storey buildings and underground cable).
5. Prepare drawing of fire alarm system.
6. Prepare drawing of single line diagrams of various types of substations (132/11KV and 11KV/400V) bus bar schemes, using standard symbols.
7. Planning of electrical installation 3 bed room house for PVC channel/duct wiring (use plan drawn for sr. No.2 above).
8. Planning of electrical installation for concealed conduit wiring (use plan of Sr.No.3 above.
9. Design earthing system for an industrial installation.
10. Prepare load survey for one workshop in institute.
11. Prepare work shop drawing (as surveyed at Sr.No.10 above) showing the details of electrical installations.
12. Planning of equipment arrangement of a panel board for the multi-storey building.
13. Drawing of connection for a panel board for each floor of building at Sr.No.12.
14. Prepare list of equipment & materials, for building as at Sr.No.7&8).
15. Estimation of material and quantity of material required for residential building.(planned at Sr.No.7 & 8 above) for light, and power circuits.
16. Prepare take-off sheet for the installation at Sr.No.12; pricing; time scheduling.
Note: Projects from Sr.No.12 to 15 may be prepared as per commercial standards.
17. Prepare cost estimate for concealed wiring for a given plan at Sr. 7 & 8 above)
18. Visit to see use of cathodic protection station & its earthing system (gas pumping station and Bridge, port, pipeline) at any one local station (Sui gas plant).

REFERENCE BOOKS

1. Electrical Estimating by Ashley.
2. A course in electrical Installation, estimating and costing by J.B Gupta.
3. Interior Electrical Wiring & Estimating (Residential) by Uhl-Dunlah.
4. Interior Electric Wiring & Estimating (Industrial) by Graham.
5. Electrical estimating and costing by N Alagappan & S Ekambaram , Tata McGraw Hill Pub. Co. Ltd. New Delhi.
6. Electrical wiring, estimating and costing by SL Uppal, Khanna Publishers New Delhi.
7. Electrical design estimating and costing by K.B Raina.
8. Electrical estimating methods by Wayne J. Delpico

ET-261 APPLICATION OF COMPUTER IN ELECTRICAL TECHNOLOGY

Total Contact Hours	T	P	C
Practical 96	0	3	1

AIM The course aims at providing practice in the development and use of simple computer programmes in high level languages such as C++, ORCAD, PSPICE and PLC ladder logic development. It provides an opportunity for the use of dedicated software packages for solving electrical networks.

LIST OF PRACTICALS

1. Introduction to C++ (Conditional & logical statements, Loops, Function call)
2. To use C++ as a tool for problem solving in Electrical Technology such as: -
 - 2.1 Application for the addition, subtraction, multiplication, division, and calculation of powers, roots and exponentials etc.
 - 2.1 Application for trigonometric and inverse trigonometric functions.
 - 2.2 Calculation of impedances in polar form.
 - 2.3 Calculation of impedances in rectangular form.
 - 2.4 Combination of impedances in series or parallel involving conversion from polar to rectangular and vice versa.
 - 2.5 Repeated use of rectangular to polar conversion as a part of subroutine of a file.
 - 2.6 Solution of R.L.C. series and parallel circuits.
 - 2.7 Calculation of A.C. powers, active and reactive components.
 - 2.8 Calculation for improvement of power factor.
3. Use of following computer software for developing/analyzing electrical networks:-
 - 3.1 ORCAD
 - 3.2 MULTISIM or PSPICE
4. Introduction to PLC (Hardware and software).
 - 4.1 Ladder logic diagram development.

REFERENCE BOOKS

1. Introductory Circuit Analysis by Boylestad. (10th Edition)
2. C++ How to Program by Deitel and Deitel
3. Manuals for
 - 3.1 ORCAD
 - 3.2 MULTISIM
 - 3.3 PSPICE
4. Introduction to PLC Controllers by Nebojsa Matic
5. Ytha Yu charles marut assembly language programming organization solution
6. PIC- microcontroller by Muhammad Ali Mazidi
7. Let us C++ by Yashwant kanetkar

ET 283

BASIC ELECTRONICS

Total Contact Hours:

Theory: 64

Practical: 96

T	P	C
2	3	3

AIMS This course is designed to enable the students to understand the basic principles of semiconductor electronics devices. It also provides basic insight in the working and applications of power electronic devices in control circuits.

The course also includes simple problem solving.

1 ELECTRON EMISSION AND BASIC SEMI CONDUCTOR THEORY. 4 Hrs.

- 1.1 Electronic emission and fundamentals of solid state electronics.
 - 1.1.1 Introduction to electronics.
 - 1.1.2 Introduction to various types of electron emission and their characteristics.
 - 1.1.3 Brief history of electron tubes and their uses.
 - 1.1.4 Semiconductors, intrinsic, extrinsic, doping.
 - 1.1.5 P type and N type materials, carriers.

2 SEMICONDUCTOR DIODES. 6 Hrs.

- 2.1 PN Junction Diode
 - 2.1.1 Diode construction, operation and applications.
 - 2.1.2 Half-wave & full wave rectifiers.
- 2.2 D.C Power supply.
 - 2.2.1 Circuit and block diagram of full-wave bridge rectifier with filter.
 - 2.2.2 Circuit and block diagram of center-tapped transformer rectifier circuit.
 - 2.2.3 Ripple factor and filtering.
 - 2.2.4 Effect of rectification on supply current.

3 SPECIAL DIODES. 8 Hrs.

- 3.1 Zener Diode.
 - 3.1.1 Construction, operation and rating of zener diode.
 - 3.1.2 Zener diode as a voltage regulators, series & shunt.
- 3.2 Photodiode and photo conductive cells.
 - 3.2.1 Construction and working of photodiode
 - 3.2.2 Photodiode as light sensor.
 - 3.2.3 Use of photo conductive cell.
- 3.3 Varactor diodes

4 FIELD EFFECT TRANSISTOR (FET) 12 Hrs.

- 4.1 FET construction and operation
 - 4.1.1 FET transistor types (JFET, MOSFET) & Construction
 - 4.1.2 MOSFET, operation.
 - 4.1.3 MOSFET Biasing
- 4.2 MOSFET Application

- 4.2.1 MOSFET as amplifier.
 - a) Types of MOSFET amplifier and their
 - b) Characteristics (CS, CG, CD).
 - b) CS as current and voltage amplifier.
 - c) Applications of MOSFET amplifiers.
- 4.2.2 MOSFET & CMOS.
 - a) MOSFET as a switch and its characteristics.
 - b) CMOS as switch.

5 BIPOLAR JUNCTION TRANSISTORS. 8 Hrs.

- 5.1 Bipolar Junction Transistor (BJT)
 - 5.1.1 Construction, Application of BJT
 - 5.1.2 BJT amplifiers.
 - 5.1.3 Characteristics of BJT amplifiers (Common Emitter, common Base, common collector).
 - 5.1.4 BJT as a voltage amplifier.
- 5.2 BJT as a switch
 - a) Characteristics of a BJT switch.
 - b) Use of BJT as switch.

6 SILICON CONTROLLED RECTIFIERS. 08 Hrs.

- 6.1 Silicon Controlled Rectifiers.
 - 6.1.1 Silicon controlled Rectifier (SCR)
 - a. SCR, construction, operation and triggering pulses.
 - b. SCR application, power control of AC and DC.
 - c. Phase control of SCR's on resistive loads

7 THYRISTORS. 10 Hrs.

- 7.1 Other Thyristors.
 - 7.1.1 Construction and operation of TRIAC & DIAC.
 - 7.1.2. DIAC/TRIAC power control circuits.
 - 7.1.3 UJT, operation, working and applications.
 - 7.1.4 Photo transistor, operation, rating and application.
 - 7.1.5 Light activated SCR (LASCR), rating and application.
 - 7.1.6 Opto-coupler, ratings & application.

8 INTEGRATED CIRCUITS. 8 Hrs.

- 8.1 Integrated Circuits (IC's) and Op-amps.
 - 8.1.1 Types of IC's
 - 8.1.2 Monolithic IC's, fabrication of components
 - 8.1.3 Types of integration.
 - 8.1.4 Operational amplifiers (op-amps), characteristics and applications.
 - 8.1.5 Basic op-amp circuits.

INSTRUCTIONAL OBJECTIVES

1 UNDERSTAND TYPES OF ELECTRON EMISSIONS AND BASIC SEMI-CONDUCTOR THEORY

- 1.1 Explain types of electron emission
- 1.2 Explain the terms-semi-conductor, intrinsic and extrinsic
- 1.3 Name types of electron tubes and their uses, brief history.
- 1.4 Explain P and N type doping
- 1.5 State majority and minority charge carriers in P & N type semi-conductors

2 UNDERSTAND THE CONSTRUCTION AND APPLICATIONS OF PN DIODES AS RECTIFIER

- 2.1 Explain formation of PN-junction.
- 2.2 Define potential barrier of PN junction.
- 2.3 Compare forward bias and reverse bias.
- 2.4 Discuss static volt ampere characteristics of diode (forward and reverse bias).
- 2.5 State applications of diode.
- 2.6 Draw and discuss half wave rectification circuit (with wave forms).
- 2.7 Draw and discuss full wave rectification circuit (with waveforms) by using:
 - a. Centre tapped transformer.
 - b. Bridge rectifier.
- 2.8 Explain the need of filters in DC power supply
- 2.9 Draw circuit diagram of filtering network (T & Pi).
- 2.10 Define term ripple factor.
- 2.11 Describe use of diode as a switch.

3 UNDERSTAND WORKING AND USES OF ZENER AND PHOTO DIODES

- 3.1 Explain the working and construction of Zener diode
- 3.2 Explain the behaviour of Zener diode in Breakdown region
- 3.3 Give ratings of zener diode.
- 3.4 Explain the Zener diode in power supplies and voltage regulation circuits.
- 3.5 Describe construction & working of photodiode.
- 3.6 Draw photodiode control circuit.

4 UNDERSTANDING CONSTRUCTION, WORKING AND USES OF BIPOLAR JUNCTION TRANSISTOR

- 4.1 Explain construction of transistors.
- 4.2 Constructional details of PNP and NPN transistor.
- 4.3 Draw PNP and NPN transistor circuits with proper biasing.
- 4.4 Describe principle of working of transistor as amplifier.
- 4.5 Describe current gain, voltage gain & power gain of a CE amplifier.
- 4.6 List uses of transistors.

- a. As a switch.
- b. As voltage & current amplifier.

5 UNDERSTAND THE WORKING AND USES OF FIELD EFFECT TRANSISTORS

- 5.1 Explain the construction & working of JFET.
- 5.2 List types of FET and their uses.
- 5.3 Describe use of JFET as an amplifier.
- 5.4 Draw characteristics curves of JFET.
- 5.5 Explain construction of MOSFET
- 5.6 State types of MOSFET (depletion mode and enhancement mode)
- 5.7 Draw symbols of IGFET and MOSFETS
- 5.8 State special handling procedures of MOSFETS

6 UNDERSTAND THE TYPES, WORKING AND USES OF THYRISTORS SPECIALLY SILICON CONTROLLED RECTIFIER, DIAC, TRIAC

- 6.1 Define a thyristor.
- 6.2 Explain construction and working operation of SCR's.
- 6.3 Draw equivalent model of SCR by two transistors analogy.
- 6.4 Draw characteristics waveforms of SCR's.
- 6.5 Explain phase control of SCR.
- 6.6 Explain use of SCR's as AC & DC Power control circuits with the help of circuit diagrams.
- 6.7 Explain the operation of Diac.
- 6.8 Draw characteristics & waveforms of Diac.
- 6.9 Explain the construction and working of TRIAC
- 6.10 Enlist applications of Diac & Triac.

7 UNDERSTAND WORKING AND USES OF SPECIAL SOLID STATE DEVICES SUCH AS UNI-JUNCTION TRANSISTOR (UJT), PHOTO TRANSISTOR, LIGHT ACTIVATED SILICON CONTROLLED RECTIFIER (LASCR), OPTO COUPLER

- 7.1 Explain the construction and working of UJT
- 7.2 Define Intrinsic stand off Ratio of UJT
- 7.3 State the equation for Peak Firing Voltage
- 7.4 Draw characteristic curve of UJT
- 7.5 Enlist common applications of UJT
- 7.6 Explain Saw-tooth oscillator using UJT, with the help of circuit diagram
- 7.7 Explain the working of photo transistor
- 7.8 State common uses of photo transistor with circuits
- 7.9 Explain the working of LASCR with the help of circuit
- 7.10 Explain the working of opto-coupler
- 7.11 State the need of opto-coupling in electronic circuits

8 UNDERSTAND BASIC WORKING AND APPLICATIONS OF IC'S AND OP-AMPS

- 8.1 Explain the term IC.

- 8.2 Define SSI, MSI, LSI, VLSI
- 8.3 Sketch a monolithic IC cross section.
- 8.4 Explain the term op-amp.
- 8.5 State the main characteristics of op-amp
- 8.6 Draw a symbol of op-amp and label it
- 8.7 Explain the working of a common op-amp with the help of block diagram (IC 741) especially, discussing “Offset null in 741 op amp”

LIST OF PRACTICALS

1. To study vacuum tubes.
2. To construct a half wave rectifier circuit and to check its output on oscilloscope.
3. To construct a full wave rectifier circuit and measure the input & outputs wave forms.
4. Demonstrate the effects of filter capacitance on DC output voltage and ripple.
5. Measure and plot the forward and reverse characteristics of a typical Zener-diode using an Electronic VOM.
6. Measure and plot the line voltage regulation properties of a typical shunt-type Zener diode voltage regulator.
7. Assemble an alarm circuit using a photo conductive cell (Project).
8. Assemble a Regulated Power Supply Circuit (Project)
9. Identify base - emitter and collector terminals and connections of NPN and PNP transistors.
10. Demonstrate and measure the effects on base current of forward and Reverse bias in the emitter - base circuit.
11. Demonstrate and measure the effects on collector current of forward and reverse bias in the emitter - base circuit and change in collector voltage.
12. Assemble a simple transistor radio circuit (Project) on PCB or Vero Board
13. Assemble a Bird Bell (Project) on PCB OR Vero Board
14. Assemble water level alarm using transistors (Project) on PCB or Vero Board
15. Demonstrate and measure the effect of drain voltage on drain current with Zero gate bias, and determine the value of drain source (Pinch - off) voltage required to produce constant drain current.
16. Measure the DC operating voltages of a typical JFET voltage amplifier.
17. Demonstrate the operation and determine the voltage gain of a typical JFET voltage amplifier.
18. Demonstrate and measure the Zero bias characteristics of a metal oxide semiconductor field effect transistor (MOSFET).
19. Demonstrate and measure the depletion mode characteristics of a metal oxide semiconductor field effect transistor (MOSFET).
20. Measure the DC operating voltage of a MOSFET voltage amplifier.
21. Measure the DC operating voltages of a Dual gate MOSFET RF amplifier.
22. Test a silicon controlled rectifier (SCR) using an Ohmmeter.
23. Demonstrate the effect of Negative gate current in an SCR.
24. Verify that an SCR operates as a semiconductor switch by using it to control DC voltage applied to a load.
25. Familiarize with the operations of a half wave variable resistor phase - control circuit of SCR.
26. Demonstrate bidirectional conduction of a gated TRIAC and DIAC.
27. Demonstrate the four triggering modes of a TRIAC.
28. Assemble a switching circuit using TRIAC-DIAC (Project)
29. Measure the inter-base resistance and determine the emitter base PN Junction diode characteristics of a uni-junction transistor.
30. Measure the peak emitter firing voltage of a uni-junction transistor.

31. Study various IC's and their pin configuration and packages.
32. Connect op-amps in functional circuits and observe their working and outputs.

REFERENCE BOOKS:

1. Basic Electronics by B.Grob.
2. Electronic Devices & Circuits by Boylstd. 10th Edition.
3. Electronics (Vol.1) by Manzar Saeed.
4. Experiments in Electronic Devices by Berlin (2nd Edition).
5. Electronics for Today & Tomorrow by Tom Duncan.

ET- 282**DIGITAL LOGIC DESIGN**

Total Contact Hours:		T	P	C
Theory	32	1	3	2
Practical	96			

AIM This course is aimed to provide sufficient knowledge in digital and industrial electronics so as to make the student capable of working with control systems employing this technology. Students should be able to understand and assemble functional projects in digital & logic electronics.

- 1 **INTRODUCTION.** 2 Hrs.
 - 1.1 Comparison of digital and analogy quantities
 - 1.2 Review of Number Systems
 - 1.3 BIT, BYTE, NIBBLE and WORD
 - 1.4 Laws and Rules Boolean Algebra

- 2 **LOGIC GATES (ALL INCLUDE LOGIC, TRUTH TABLE AND TTL CIRCUITRY)** 4 Hrs.
 - 2.1 NOT (Inverter)
 - 2.2 OR
 - 2.3 AND
 - 2.4 NAND
 - 2.5 NOR
 - 2.6 XOR
 - 2.7 XNOR
 - 2.8 Application of Gates.

- 3 **ARITHMETIC LOGIC CIRCUITS(INCLUDING LOGIC AND CIRCUITY).** 3 Hrs.
 - 3.1 Half adders
 - 3.2 Full adders
 - 3.3 Half and full subtractor
 - 3.4 Comparators

- 4 **COMBINATIONAL LOGIC AND DATA PROCESSING CIRCUITS.** 3 Hrs.
 - 4.1 Decoders
 - 4.2 BCD-to-Decimal Decoders (such as 7445)
 - 4.3 Seven-Segment Decoders and Displays
 - 4.4 Encoders(IC's such as 74147)
 - 4.5 Multiplexers and logic (IC's such as 74150)
 - 4.6 De-Multiplexers (IC's such as 74154)

- 5 **LATCHES AND FLIP-FLOPS.** 4 Hrs.
 - 5.1 RS Latch

	5.2	Clocked RS Flip-Flop	
	5.3	D Flip-Flop	
	5.4	JK Flip-Flop	
	5.5	T-Flip-Flop	
6		CLOCKS & TIMERS.	4 Hrs.
	6.1	TTL Clock	
	6.2	555 - astable, monostable	
	6.3	Applications	
7		SHIFT REGISTERS.	3 Hrs.
	7.1	Introduction, shift-Right and shift Left	
	7.2	Serial in-serial out	
	7.3	Serial-in parallel-out	
	7.4	Parallel-in serial-out	
8		COUNTERS.	3 Hrs.
	8.1	Introduction, types	
	8.2	Asynchronous counter	
	8.3	2-BIT, 3-BIT, Decade, Asynchronous counter	
	8.4	Synchronous Counter	
	8.5	2-BIT, 3-BIT, Decade Synchronous counters	
9		MEMORIES.	3 Hrs.
	9.1	Introduction, volatile, non-volatile,	
	9.2	ROM, Types of ROM	
	9.3	RAM, Types of RAM	
10		D/A AND A/D CONVERTERS.	3 Hrs.
	10.1	Introduction	
	10.2	D/A converter	
	10.3	A/D converter	

TEXT/REFERENCE BOOKS

- 1 Digital principles and applications by Albert Paul Malvino, Goutam Saha, Donald P Leach – 7th edition
- 2 Digital Fundamentals by FLOYD
- 3 Digital logic and computer design by M. Morris Mano – 5th edition

INSTRUCTIONAL OBJECTIVES

- 1 KNOW BASIC TERMS RELATED TO DIGITAL ELECTRONICS.**
 - 1.1 State in a tabulated form the merits and demerits of analog & digital quantities
 - 1.2 Define basic terms related to digital electronics.

- 2 UNDERSTAND THE WORKING OF LOGIC GATES, USING TRUTH TABLES AND TTL and CMOS CIRCUITRY.**
 - 2.1 Define the logic gates NOT, OR, AND, NAND, NOR, XOR, XNOR.
 - 2.2 Draw truth tables for the logic gates, showing symbols and equations.
 - 2.3 Explain logic gates, using TTL and CMOS circuitry.

- 3 UNDERSTAND ARITHMETIC CIRCUITS FOR LOGIC CIRCUIT ELEMENTS.**
 - 3.1 Define elements of arithmetic logic circuits: half-adder, full-adder, subtractor, comparators.
 - 3.2 Explain the operation of arithmetic logic circuits (as above), using symbols, and block-diagram.
 - 3.3 Explain the inter-connection and inter-conversion of arithmetic logic circuits

- 4 UNDERSTAND THE WORKING AND USES OF COMBINATIONAL LOGIC CIRCUITS, INCLUDING DATA PROCESSING CIRCUITS.**
 - 4.1 Define the terms multiplexers, demultiplexers, decoders, encoders.
 - 4.2 Explain multiplexers, using logic circuits & block-diagrams (multiplexers using IC's such as 74150).
 - 4.3 Explain Demultiplexers using block-diagrams (using IC's such as 74154).
 - 4.4 Explain using block diagram, BCD and its conversion to Decimals, using IC's, such as 7445.
 - 4.5 Explain seven segments decoders, showing block diagrams, giving examples for letters & digits.
 - 4.6 Describe the operation of combinational logic circuits as applied to data processing circuits.
 - 4.7 Explain the working of 7-segment display circuit

- 5 UNDERSTAND FLIP-FLOPS AS ELEMENTS OF DIGITAL LOGIC CIRCUITS, USING BLOCK DIAGRAMS.**
 - 5.1 Define Latch flip-flops & triggers.
 - 5.2 State different types of flip-flops at triggers
 - 5.3 Explain various flip-flops (RS, Clocked RS, D, JK and T), using block diagrams for describing their functions.
 - 5.4 Describe the functions of Edge trigger circuits, with the help of circuit diagram.

- 6 UNDERSTAND THE WORKING OF CLOCKS & TIMERS FOR**

APPLICATIONS IN DIGITAL LOGIC CIRCUITS.

- 6.1 Define timers, clocks, enlisting their types
- 6.2 Explain with the help of block diagram, the TTL Clock
- 6.3 Explain 555 timer, describing its use as astable and monostable multivibrators
- 6.4 Give examples of the use of clocks and timers for digital circuits, showing block diagrams.

7 EXPLAIN THE FUNCTION OF SHIFT REGISTERS, USING BLOCK DIAGRAMS.

- 7.1 Define shift-registers, stating its various types
- 7.2 Describe the function of the following shift registers, using block-diagrams:-
 - 7.2.1 Serial-in, serial-out (SISO)
 - 7.2.2 Serial-in, parallel-out (SIPO)
 - 7.2.3 Parallel-in, serial-out (PISO)
 - 7.2.4 Parallel-in, parallel-out (PIPO)
- 7.3 Explain shift-Right and Shift-Left registers

8 UNDERSTAND DIGITAL COUNTERS & CLOCK USING BLOCK DIAGRAMS.

- 8.1 Enlist various types of counters
- 8.2 Describe various types of counters using block diagram (Asynchronous, synchronous).
- 8.3 Explain working 2-BIT, 3-BIT, Decade Asynchronous Counters.
- 8.4 Explain working of 2-BIT, 3-BIT, Decade Synchronous Counters.

9 KNOWS VARIOUS TYPES OF MEMORIES.

- 9.1 Define various types of memories: ROM, PRM, EPROM, RAM.
- 9.2 State memory of common memory devices in KB, MB.
- 9.3 Know the system of memory addressing.

10 UNDERSTAND INTERCONVERSION OF ANALOG AND DIGITAL SIGNALS, USING BLOCK DIAGRAMS.

- 10.1 State need for D/A and A/D conversion.
- 10.2 Describe the system of D/A conversion using block diagram.
- 10.3 Explain the system of A/D conversion, using block diagram.
- 10.4 Give example of a simple system from analog input to analog output, using A/D & D/A converters.

ET-282-DIGITAL LOGIC DESIGN

LIST OF PRACTICALS

- 1 Identify and verify truth tables for AND, OR, NOT Gates IC's
- 2 Identify and verify truth tables for NOR, NAND, XOR, XNOR, Gates IC's
- 3 Construct and verify truth tables for half adder, full adder, subtractor
- 4 Study multiplexing and demultiplexing circuits
- 5 Construct and verify decoder circuit using 74-series IC
- 6 Construct seven-segment decoder circuit and verify its function
- 7 Construct and verify the functions of Latch using NAND, NOR Gates.
- 8 Construct and verify the functions of Clocked RS Flip-Flop
- 9 Construct and verify the functions of D Flip-Flop
- 10 Construct and verify the functions of JK Flip-Flop
- 11 Connect a 555 IC as
 - 11.1 Astable multivibrator
 - 11.2 Monostable multivibrator
 - 11.3 Bistable multivibrator
- 12 Connect and observe the working of shift registers (SISO, SIPO, PISO, PIPO).
- 13 Identify, connect and observe working of ripple and synchronous counters
- 14 Connect and observe working of D/A and A/D converters
- 15 Assemble and observe working of frequency counter
- 16 Prepare project to demonstrate application of digital logic design – 4 weeks
 - 16.1 Design the project
 - 16.2 Implementation on bread board
 - 16.3 Implementation on PCB

اسلامیات / مطالعہ پاکستان

نی پنا ی	GENERIC	نصاب (سائنس)
1 0 1		حصہ اول اسلامیات
کس وقت سے 20 بجے		حصہ دوم مطالعہ پاکستان
		موضوعات:
		قرآن مجید
		1- سورۃ المائدہ - ایہ الفری - سورۃ البقرۃ کی سترہ آیات از اسرار الرسول سے تا آخر سورۃ مائدہ - خلاق مع ترجمہ و تفسیر
		2- بنی منتخب احادیث سے ترجمہ و تفسیر
		3- بنی اسلام علی خمس شہادت لالہ الالمو اقلم ائصلونہ و اینا انزکوة و حج بیت و صوم رمضان
		4- لہذین انصیحتہ
		5- لمنشاء مومن
		6- للمومن علی المومن سنت خصای بعد ما دامرض و تشہدہ لائمات و یحبہ لنا دعا
		7- لیسیم علیہ نابقہ و لیعتہ انا عظم و فصیحطہ ناغاب اوشہد
		8- لا یغفر لہم اللہ
		9- لا یغفر لہم اللہ
		10- ان اللہ حرم علیکم عقوق المہات و تضاعتہ اعمال
		11- لیسر اولاتعسر اولاتنفرا
		12- دلق طعم الایمان من مرضی باللہ و بالاسلام دین بمعجمتینیا
		13- لخص الذکر لالہ الالمہ
		14- حقوق و قرائن
		15- حصن تعلیم بطور فرس - والدین اور اولاد کے حقوق و فرائض - ہمد کے حقوق
		16- اسلام کی اخلاقی اقدار
		17- عہدہ اشتغال - عہدہ درگذر - ایفائے عہد - ہمت - ایثار و قربانی

سال سوئم
حصہ اول اسلامیات

تدریس مقاصد

قرآن حکیم

عمومی مقصد: منتخب سورتوں اور آیات کی روشنی میں اسلام کے بنیادی مقاصد اور عبادت جان سکے
خصوصی مقاصد: طالب علم اس قتل ہو جائے گا کہ
سورۃ الفاتحہ: آیتہ الکرسی۔ سورۃ بقرۃ کی آخری آیات از امن الرسول سے اور سورۃ 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 پادشاہی اللہ کی ہوگی

☆ عبادت 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

☆ تعلیم انبیاء پر ایمان لانا ضروری ہے

☆ رسولؐ ملا کہ کتب سلویہ پر ایمان لانا فرض ہے

☆ اطاعت حقیقی صرف اللہ کے لیے ہے

☆ اسلامی احکامات پر عمل کرنا انسانی بسلا 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 مقصد:

☆ احادیث کا ترجمہ بیان کر سکے

- ☆ اعلیٰ بیٹ کی تشریح کر سکے
- ☆ معاشرتی اور انفرادی زندگی میں اعلیٰ بیٹ سے راہنمائی حاصل کر سکے
- حقوق و فرائض**
- عمومی مقصد: اسلامی معاشرے کا ایک اہم فرد بن سکے
- خصوصی مقاصد:
- ☆ والدین کے حقوق و فرائض بیان کر سکے
- ☆ بھائیوں کے حقوق بیان کر سکے
- ☆ اسلام میں حقوق و فرائض کی صورت میں اپنے اندر خدمتِ خلق کا جذبہ پیدا کر سکے
- اسلامی اقدار
- عمومی مقصد: طالب علم بن سکے گا کہ تعلیم کا مقصد حسنِ اخلاق سے متصف ہو گا ہے
- خصوصی مقاصد
- ☆ اخلاق کے معنی و مفہوم کو بیان کر سکے
- ☆ اسلام میں حسنِ اخلاق کی اہمیت بیان کر سکے
- ☆ قرآن و سنت کی روشنی میں صبر و استقامت کی اہمیت بیان کر سکے
- ☆ اسلام میں عفو و درگزر کی اہمیت بیان کر سکے
- ☆ ایقانے عہد کی اہمیت بیان کر سکے
- ☆ اذیت کے معنی و مفہوم کو بیان کر سکے
- ☆ اذیت اسلامی کی اہمیت بیان کر سکے
- ☆ اسلام کی اعلیٰ اقدار کو اپنا کر مثالی معاشرہ پیدا کر سکے

ٹی پی سی
1 0 1
کل وقت: 20 گھنٹے

GEN 311

نصاب (سہل سوئم)
مظاہرہ پاکستان
حصہ دوم

موضوعات

- ☆ قیام پاکستان
- ☆ پونڈری کمیشن
- ☆ ریڈ کلف ایوارڈ
- ☆ تقسیم بنگلہ و گلگت
- ☆ تقسیم پنجاب
- ☆ مسئلہ مہاجرین
- ☆ ریاست کالہاں
- ☆ ریاست جموں و کشمیر
- ☆ نسری پالی کا تنازعہ
- ☆ قرار دلو مقاصد
- ☆ علماء کے بائیس نکات
- ☆ 1956-1962 اور 1973 کے دستاویز کی اسلامی دفعات
- ☆ پاکستان کا محل وقوع اور اس کی جغرافیائی اہمیت
- ☆ 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
- ☆ بنگل اور گلگت 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
- ☆ سرحدی پٹی کے تنازعہ کو بیان کر سکے
- ☆ قرار داد مقاصد کی تفصیلات بیان کر سکے
- ☆ 22 علماء کے متفقہ اسلامی نکات بیان کر 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
- ☆ پاکستان میں قدرتی وسائل (تیل-گیس-کونکر) کے بارے میں بیان کر سکے

(غیر مسلم طلباء کے لئے)

ٹی پی سی
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کل وقت: 20

Gen 311

نصاب اخلاقیات

سال سوئم

موضوعات

☆ احساس ذمہ داری

☆ مثبت ذہن

☆ عدل و انصاف

☆ قومی خدمت کا جذبہ

☆ ذکوہ نظر کی پاکیزگی

☆ احترام آدمیت

☆ شائستگی

☆ خود درگزر

☆ بردباری

☆ خود انحصاری

☆ اثر و نفوذ

☆ جامعیت

☆ اپنی ذات کی معرفت (بذریعہ ہم عمر طلباء۔ اساتذہ۔ اہم شخصیات لواریہ)

(غیر مسلم طلباء کے لئے)

نصاب اخلاقیات

سل سوئم

تدریس مقاصد

- ☆ عمومی مقصد: 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 گا 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 اوارہ 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 ☆

MGM-321 BUSINESS COMMUNICATION

T	P	C
1	0	1

Total contact hours

Theory 32 Hrs.

Prerequisites: The students shall already be familiar with the language concerned.

AIMS: The course has been designed to enable the students for:

1. Development of communication skills.
2. Understanding basic principles of good and effective business letter 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 communique
 - 1.5 Communication flow
 - 1.6 Communication for self development
- 2. ORAL 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**
- 7.1 Reading problems.
 - 7.2 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.

RECOMMENDED BOOKS

1. Sh. Ata-ur-Rehman Effective Business Communication & Report Writing.
2. Ulman J.N. Could JR. Technical Reporting.

MGM-321 BUSINESS COMMUNICATION.

INSTRUCTIONAL OBJECTIVES

- 1. UNDERSTAND THE COMMUNICATION PROCESS.**
 - 1.1 Explain basic terminology of business communication
 - 1.2 State the benefits of two way communication.
 - 1.3 Describe a model of communication process.
 - 1.4 Explain the major communication methods used in organization.
 - 1.5 Identify the barriers to communication and methods of overcoming these barriers.
 - 1.6 Identify misconceptions about communication.

- 2. UNDERSTAND THE PROCESS OF ORAL.**
 - 2.1 Identify speaking situations with other peoples.
 - 2.2 Identify the strategy steps of speaking.
 - 2.3 Identify the characteristics of effective speaking.
 - 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.
 - 2.8 Letters writing skill.

- 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 SKILL 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 feed back.

- 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 OUT-LINE, 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 COMMUNICATIONS.

- 8.1 State the purpose and characteristics of major types of meeting.
- 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.
- 8.6 Writing skill of minutes of meeting.

MGM-311 INDUSTRIAL MANAGEMENT AND HUMAN RELATIONS.

Total Contact Hours

Theory	32	T	P	C
Practical	0	1	0	1

AIMS Due to study of this subject, the students will be able to develop the management skill and understanding the basic principles of management and human relation and develop psychological approach to solve the labour problems.

COURSE CONTENTS

- 1. INDUSTRIAL PSYCHOLOGY. 2 Hours**
 - 1.1 History and definition.
 - 1.2 Nature and scope.
- 2. LEADERSHIP 1 Hour**
 - 2.1 Definition and types.
 - 2.3 Qualities of a good leader.
- 3. MOTIVATION 2 Hours**
 - 3.1 Definition.
 - 3.2 Types (Financial and non financial motives).
 - 3.3 Conflict of motives.
- 4. MORALE 1 Hour**
 - 4.1 Importance.
 - 4.2 Development.
 - 4.3 Measurement.
- 5. HUMAN ENGINEERING. 1 Hour**
 - 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. 2 Hours**
 - 6.1 Definition and distinction.
 - 6.2 Psychological causes.
 - 6.3 Objective causes.
 - 6.4 Prevention
- 7. INDUSTRIAL ACCIDENTS 2 Hours**
 - 7.1 Psychological causes.
 - 7.2 Objective causes.

	7.3	Prevention	
8.		INDUSTRIAL PREJUDICE	2 Hours
	8.1	Causes	
	8.2	Remedies	
9.		PUBLIC RELATIONS.	2 Hours
	9.1	Importance	
	9.2	Functions	
10.		GUIDANCE AND COUNSELLING	2 Hours
	10.1	Importance	
	10.2	Choice of job.	
	10.3	During service.	
11.		JOB EVALUATION	2 Hours
	11.1	Importance	
	11.2	Methods	
	11.3	Job satisfaction	
	11.4	Work simplification.	
12.		INDUSTRIAL MANAGEMENT	2 Hours
	12.1	Introduction	
	12.2	Functions of management.	
	12.3	Subdivisions of management	
	12.4	Objectives of industrial management.	
13.		PERSONNEL SELECTION.	2 Hours
	13.1	Recruitment of employees.	
	13.2	Training.	
	13.3	Effects of training on production and product cost.	
14.		WORKING CONDITIONS.	2 Hours
	14.1	Importance and consideration.	
	14.2	Effects on efficiency and per unit cost.	
15.		TIME AND MOTION STUDY.	3 Hours
	15.1	Concept and importance.	
	15.2	Sequence of motion study.	
	15.3	Principles of motion study.	
	15.4	Steps to time study.	
	15.5	Determination of operations time.	
16.		QUALITY CONTROL.	2 Hours
	16.1	Concept and advantages	

16.2 Methods.

17. ROLE OF FOREMAN IN MANAGEMENT.

2 Hours

17.1 Foreman's abilities.

17.2 Duties and functions.

BOOKS RECOMMENDED:

1. C.S. Meyers, Industrial Psychology, Oxford University Press, London.
2. Smith Wakley, Psychology of Industrial Behaviors, Mc-Graw Hill, New York.
3. Ghulam Hussain, Nizamat-e-Sanaat Aur Insani Rawabat, Ilmi Kitab Khana, Urdu Bazar, Lahore.
4. Andrew R. Megill, The Process of Management William M New Man.
5. Richard N Omen, Management of Industrial Enterprises.

MGM-311 INDUSTRIAL MANAGEMENT AND HUMAN RELATIONS.

INSTRUCTIONAL OBJECTIVES

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

- 1. KNOW INDUSTRIAL PSYCHOLOGY.**
 - 1.1 Describe brief history if industrial psychology.
 - 1.2 Describe in detail definition of industrial psychology.
 - 1.3 State nature and scope of industrial psychology.
 - 1.4 Elaborate the management skills.

- 2. KNOW LEADERSHIP.**
 - 2.1 Define leadership.
 - 2.2 Describe types of leadership.
 - 2.3 State qualities of a good leader.

- 3. UNDERSTAND MOTIVATION.**
 - 3.1 Define motivation.
 - 3.2 Describe financial and non financial motives.
 - 3.3 Explain conflict of motives.

- 4. KNOW MORALE.**
 - 4.1 State importance of morale.
 - 4.2 Describe development of morale.
 - 4.3 State the method of measurement of morale.

- 5. UNDERSTAND 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 INDUSTRIAL FATIGUE AND BOREDOM.**
 - 6.1 Define fatigue and boredom.
 - 6.2 Describe psychological causes of fatigue and boredom.
 - 6.3 Describe objective causes of fatigue and boredom.
 - 6.4 Explain measures to prevent fatigue and boredom.

- 7. UNDERSTAND INDUSTRIAL ACCIDENTS.**
 - 7.1 Explain psychological causes of industrial accidents.
 - 7.2 Explain objective causes of industrial accidents.
 - 7.3 Explain measures to prevent industrial accidents.

- 8. UNDERSTAND INDUSTRIAL PREJUDICE.**

- 8.1 Define prejudice
 - 8.2 Explain causes of industrial prejudice.
 - 8.3 Explain remedies of industrial prejudice.
- 9. UNDERSTAND THE SIGNIFICANCE OF PUBLIC RELATIONS.**
- 9.1 Explain importance of public relations.
 - 9.2 Explain functions of public relations.
- 10. UNDERSTAND THE NEED FOR GUIDANCE AND COUNSELLING.**
- 10.1 State importance of guidance and counselling.
 - 10.2 Explain the role of guidance and counselling in choosing the job.
 - 10.3 Describe help of guidance and counselling during service.
- 11. UNDERSTAND 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 INDUSTRIAL MANAGEMENT.**
- 12.1 Define management.
 - 12.2 State functions of management.
 - 12.3 Enlist subdivision of management.
 - 12.4 Explain objectives of industrial management.
- 13. UNDERSTAND TRAINING AND ITS EFFECTS.**
- 13.1 Describe the recruitment procedure of employees in an industrial concern.
 - 13.2 Explain training.
 - 13.3 Identify the kinds of training.
 - 13.4 Explain the effects of training on production and product cost.
- 14. UNDERSTAND THE EFFECT OF WORKING CONDITION ON EFFICIENCY.**
- 15.1 Explain importance of working condition.
 - 15.2 Describe air-conditioning, ventilation, lighting and noise.
 - 15.3 State the effects of good working conditions on efficiency and per unit cost.
- 15. UNDERSTAND TIME AND MOTION STUDY.**
- 15.1 Explain the concept.
 - 15.2 Describe the importance of work study.
 - 15.3 Explain the sequence of motion study.
 - 15.4 State the principles of motion study.
 - 15.5 Describe the steps for carrying out time study.
 - 15.6 Explain the method of determination of operations time.

16. UNDERSTAND THE METHODS OF QUALITY CONTROL.

- 16.1 Define quality control
- 16.2 State the advantages of quality control.
- 16.2 Explain methods of quality control.

17. UNDERSTAND THE ROLE OF FOREMAN IN AN INDUSTRIAL UNDERTAKING.

- 17.1 Explain ability of the foreman.
- 17.2 Enlist duties of foreman.
- 17.3 Describe functions of foreman as middle management.

Total Contact Hours

Theory	128	T	P	C
Practical	192	4	6	6

AIM At the end of this course the student will be able to have an insight into the construction, working principles and behavior of machines under different operating conditions and an awareness of their losses and efficiency. The knowledge gained will form basis for carrying out repair and maintenance of these machines, an area covered in the programme concurrently.

COURSE CONTENTS

- 1 SINGLE PHASE TRANSFORMER 36 Hrs.**
- 1.1 Definition, principle, basic parts.
 - 1.2 EMF equation, transformation ratio.
 - 1.3 Classification of transformer - core, mode of operation, use and cooling.
 - 1.4 Transformer operation (ideal) - On No load, on load, with resistive load, phasor diagram, with inductive, phasor diagram, with Capacitive load, phasor diagram.
 - 1.5 Transformer operation (Practical) - parameters, primary resistance, secondary resistance, primary leakage reactance, secondary leakage reactance, secondary, equivalent resistance, equivalent reactance referred to secondary, referred to primary, Exciting conductance and susceptance, equivalent circuit diagrams referred to primary & secondary, operation of practical transformer on load of different power factor, phasor diagram, approximate and exact voltage drop in transformer, regulation, percent resistance, reactance and impedance.
 - 1.6 Transformer losses & efficiency, Iron and copper losses. Ordinary and all - day efficiencies, maximum efficiency, cooling of transformers.
 - 1.7 Transformer tests and specifications - Insulation test, Ratio test, Polarity test, open circuit test, short circuit test, Back-to-back/Sumpner's test.
 - 1.8 Parallel operation of 1 phase transformers
 - 1.9 Special transformers, construction, principle and use - Instrument transformers, Auto transformer (with its apparent power advantage), Welding transformer, Rotating core transformer.
- 2. 3 -PHASE TRANSFORMER. 15 Hrs.**
- 2.1 Construction and working of 3 phase transformer.
 - 2.2 Connection groups of 3 phase transformer, name-plate rating.
 - 2.3 Connection of single phase transformers for 3 phase & 2 phase transformation, - Star-Star, Star-Delta, Delta-Star, Delta-Delta, open Delta, Scott, Transformation of 3 phase to 6 phase & vice versa.
 - 2.4 Calculation of 3-phase transformer.
- 3 A.C MOTORS INTRODUCTION**

- 3.1. General. **1 Hr.**
- 3.2. Preference of A.C motors over DC motors.
- 3.3. Classifications.

- 4. THREE PHASE INDUCTION MOTORS. **20 Hrs.****
 - 4.1 Production of rotating magnetic field by 3 phase & 2 phase EMFs.
 - 4.2 Construction of squirrel cage & wound rotor induction motor.
 - 4.3 Principle of rotation of S.C. rotor, synchronous speed, rotor speed, slip, frequency of rotor induced current.
 - 4.4 Motor parameters (stator resistance, reactance, rotor resistance, rotor reactance in starting & running condition. Condition for maximum starting & running torque.
 - 4.5 Power stages in induction motor, Resistance measurement, No load & blocked rotor tests to determine losses, efficiency & parameters of motor. Equivalent circuit.
 - 4.6 Starting of 3 ph induction motor.
 - 4.7 Speed control of induction motor.

- 5. SINGLE PHASE MOTOR. **12 Hrs.****
 - 5.1 Classification.
 - 5.2 Split phase motor.
 - 5.3 Shaded pole motor.
 - 5.4 Repulsion motor.
 - 5.5 Series motor.
 - 5.6 Fan Motor as example of External Rotor motor

- 6. SYNCHRONOUS GENERATOR. **32 Hrs.****
 - 6.1. Construction - Stator, Rotor, Armature winding (single layer, two layer, chain), Hydrogen cooling for large machines
 - 6.2 Principle. EMF equation.
 - 6.3. Performance of Synchronous Generator on Load.
 - 6.4 Voltage variation on load
 - 6.5 Armature Reaction
 - 6.6 Synchronous impedance
 - 6.7. Phasor Diagram of Loaded Synchronous Generator on different power factors.
 - 6.8. Regulation & its Determination by Synchronous Impedance Method.
 - 6.9 O.C. and S.C. tests
 - 6.10 Calculation of voltage regulation
 - 6.11 Synchronization of Generator by different methods (lamp bright, lamp dark, synchroscope).
 - 6.12 Load sharing.
 - 6.13 Brushless A.C. Generator: Construction, Working & Uses.

- 7. SYNCHRONOUS MOTOR. **12 Hrs.****
 - 7.1. Principle, construction, operation & uses of 3 phase synchronous motor

- 7.2. Principle, construction operation, characteristics & uses of unexcited single phase synchronous motor (Reluctance & Hysteresis Motor).
- 7.3. Permanent magnet synchronous motor – efficiency considerations and starting of motor.

RECOMMENDED BOOKS:-

1. A.C Machines Fundamentals by J. Chapmann
2. B.L Theraja. Electrical Technology
3. Electrical Machines by V.U Bakhshi & V.A Bakhshi
4. A.C Machines by Afzal Bashir & Khalid Mahmood
5. Philips Kemp. Alternating Current Electrical Engineering
6. Drinkall Hadik Grant. Alternator Current Motors
7. Kates-Stafford. Electrical Generator
8. Coral H-Dunlop. Transformers

INSTRUCTIONAL OBJECTIVES

- 1. UNDERSTAND CONSTRUCTION & PRINCIPLE OF TRANSFORMER.**
 - 1.1. Define transformer as step up and step down.
 - 1.2. Describe parts of transformer.
 - 1.3. Explain principle of transformer.
 - 1.4. a) Describe classification of transformer.
b) Differentiate core type & shell type transformer.
 - 1.5. Derive EMF equation of transformer.
 - 1.6. Solve problems related to above.

- 2. UNDERSTAND OPERATION OF TRANSFORMER ON NO LOAD AND LOAD.**
 - 2.1 Differentiate between ideal & practical transformer.
 - 2.2 Draw the phasor diagram of transformer on no load and load
 - 2.3 Explain components of no load primary current.
 - 2.4 Calculate energy component & magnetizing component of no load current.
 - 2.5 Explain the Inrush current when load is connected.
 - 2.6 Distinguish between primary leakage flux, & secondary leakage flux.
 - 2.7 State methods of reducing leakage flux.
 - 2.8 State the relation of current & transformation ratio rating it to KVA.

- 3. UNDERSTAND EQUIVALENT CIRCUIT OF TRANSFORMER.**
 - 3.1 Identify the primary resistance, secondary resistance, primary reactance, secondary reactance and magnetizing - branch components
 - 3.2 Convert the parameters of primary side onto secondary and vice versa, calculating equivalent values
 - 3.3 Draw the equivalent circuit of transformer.
 - 3.4 Draw the phasor diagram of transformer loaded with resistive, inductive, capacitive load with parameters referred to (a) both sides (b) primary (c) secondary.
 - 3.5 Solve problems on equivalent circuit of transformers under different loading conditions.

- 4. CALCULATE REGULATION OF TRANSFORMER.**
 - 4.1 Define regulation.
 - 4.2 State factors on which regulation depend.
 - 4.3 Explain the voltage drop in transformer.
 - 4.4 Derive expression for approximate voltage drop & discuss exact voltage drop.
 - 4.5 Define % Resistance, % Reactance & % Impedance.
 - 4.6 State formula for % impedance.

- 4.7 Calculate regulation for various loading conditions.
- 5. CALCULATE EFFICIENCY OF TRANSFORMER.**
 - 5.1 List the losses in transformer.
 - 5.2 Identify the parts in which these losses occur and the causes for the losses to occur.
 - 5.3 Define efficiency.
 - 5.4 Differentiate between commercial efficiency & all day efficiency.
 - 5.5 Calculate all day efficiency.
 - 5.6 Solve numerical on Losses & Efficiency
 - 5.7 Derive conditions for maximum efficiency and hence calculate maximum efficiency.
- 6. UNDERSTAND TESTS OF TRANSFORMER.**
 - 6.1 List transformer tests.
 - 6.2 Describe various tests.
 - 6.3 Interpret the results of tests as parameters of equivalent circuit and components of losses.
 - 6.4 Solve numerical problems, related to open circuit test & short circuit test.
- 7. OPERATE TRANSFORMER IN PARALLEL.**
 - 7.1 State the need of parallel operation.
 - 7.2 Describe the conditions for parallel operation and how these are fulfilled.
 - 7.3 Explain parallel operation under various conditions
 - 7.4 Solve problems on parallel operation of transformers, related to load-sharing.
- 8. UNDERSTAND CONSTRUCTION AND WORKING OF SPECIAL PURPOSE TRANSFORMER.**
 - 8.1 Describe construction & working of special purpose transformers (such as auto-transformer, instrument transformers, welding transformer, rotating core transformer).
 - 8.2 State the uses of special purpose transformer.
 - 8.3 Describe the apparent power advantage of Auto transformer.
- 9. UNDERSTAND CONSTRUCTION & WORKING OF 3 PHASE TRANSFORMER.**
 - 9.1 State advantages & disadvantages of 3 phase transformer over 1 phase transformer and 3-phase transformer over a bank of three phase transformers.
 - 9.2 Describe the construction of 3 phase transformer (insulation, winding arrangement, core, cooling, terminals).
- 10. UNDERSTAND THE CONNECTION GROUPS OF 3- PHASE TRANSFORMER.**
 - 10.1 Enlist connection groups of 3 phase transformer.
 - 10.2 Explain the voltage relationships & phasor diagrams of different groups along with

- their application
- 10.3 Explain the vector groups: Dd0, Yy0, Dd6, Dy11.
- 11. A) UNDERSTAND TRANSFORMATION FROM 1 PHASE TO 2 PHASE & 3 PHASE & VICE VERSA USING SINGLE PHASE TRANSFORMERS.**
- B) UNDERSTAND TRANSFORMATION OF 3 PHASE TO SIX PHASE.**
- 11.1 Explain with phasor diagram transformation of 1 phase to 3 phase & 2 phase by using 3/2 single phase transformer (Star-star, Delta-Delta, Star-Delta, Delta-Star, open delta, scott.)
- 11.2 Compare different connection as mentioned above
- 11.3 Draw diagram of different methods for obtaining 6 phase from 3- phase (Double star, double delta, diametrical)
- 11.4 Explain the 6 phase to 3 phase transformation.
- 12. UNDERSTAND THE COOLING METHODS OF TRANSFORMER.**
- 12.1 State necessity of cooling of transformer
- 12.2 List cooling methods.
- 12.3 Explain methods of cooling
- 12.4 State the location & function of (a) Breather (b) explosion vent (c) conservator (d) oil level indicator.
- 12.5 Explain the construction and operation of Buchholz's Relay.

A.C. MOTORS.

- 1. COMPREHEND CONSTRUCTION AND WORKING OF A.C. SYNCHRONOUS MOTORS.**
- 1.1 List parts of synchronous motor.
- 1.2 Explain principle of production of rotating magnetic field
- 1.3 Explain principle of working of synchronous motor
- 1.4 Explain the performance of synchronous motor on load with phasor diagram
- 1.5 Explain the effect of varying excitation on the AC line current (magnitude and phase) in synchronous Motors.
- 1.6 Explain the significance and use of V-curves of synchronous motor
- 1.7 Solve simple problems related to induced e.m.f., line current and PF.
- 1.8 Explain the phenomenon of hunting
- 1.9 State how hunting is prevented
- 1.10 State starting methods of Synchronous motor
- 1.11 State the field of application of synchronous motor
- 1.12 Describe the construction & principle of unexcited synchronous motor (Reluctance & Hysteresis Motor)
- 1.13 Compare the efficiency of a permanent magnet synchronous motor with induction motor
- 1.14 Fan Motor as example of External Rotor motor
- 2. COMPREHEND THE CONSTRUCTION AND WORKING OF 3 PHASE**

INDUCTION MOTORS.

- 2.1 State the function of different parts of 3 phase induction motor
- 2.2 State the principle of working of 3-phase induction motor
- 2.3 Derive the equation relating torque, power and slip, and for the pull out torque
- 2.4 Solve problem on the performance of induction motor relating torque, slip and power.
- 2.5 Explain the relationship between slip and torque using slip-torque curve.
- 2.6 Explain losses in an induction motor
- 2.7 Calculate efficiency of induction motor for given slip and torque/power conditions.
- 2.8 Explain blocked rotor and no-load tests.
- 2.9 Derive parameters of equivalent circuit from tests.
- 2.10 Explain general principles of 3 phase stator winding
- 2.11 Define terms related to winding
- 2.12 Classify the windings as short and full-pitched, single and double-layer, progressive and retrogressive
- 2.13 Draw winding diagrams of typical slot pole combinations
- 2.14 State the methods of starting of induction motor
- 2.15 Sketch the circuit diagram of induction motor & explain its working with D.O.L. starter, Y-delta starter, Auto transformer starter
- 2.16 Describe speed control methods

3. COMPREHEND WORKING OF 1- PHASE INDUCTION MOTOR.

- 3.1 State the types of 1 phase Induction motor
- 3.2 Explain principle of working of split phase, capacitor & shaded pole motor
- 3.3 State speed control methods of 1 phase induction motor

4. COMPREHEND WORKING OF COMMUTATOR MOTOR.

- 4.1 State different type of AC commutator motors
- 4.2 Explain the principle of repulsion motor, a.c, series motor, universal motor
- 4.3 Describe speed control methods of commutator motor

5. UNDERSTAND BRAKING OF AC MOTORS.

- 5.1 Define braking
- 5.2 Describe methods of braking of induction motor
- 5.3 Explain the principle of braking as applied to induction motor

SYNCHRONOUS GENERATOR

1. UNDERSTAND THE CONSTRUCTION & CLASSIFICATION OF SYNCHRONOUS GENERATOR.

- 1.1 Describe the construction of alternator
- 1.2 Classify alternators based on speed and poles (salient, smooth cylindrical).
- 1.3 Compare rotating field type with rotating armature type
- 1.4 List the parts with materials used
- 1.5 State the function of each part

- 1.6 Describe salient pole construction
 - 1.7 List types armature winding used in synchronous generator
 - 1.8 Define terms related to armature winding: pitch and pitch factors, distribution factor, single and double layer, overhang etc.
 - 1.9 Compare different armature windings
 - 1.10 Draw the winding diagrams
- 2. UNDERSTAND THE PRINCIPLE OF SYNCHRONOUS GENERATOR**
- 2.1 Explain the principle of alternator
 - 2.2 Derive the emf equation of synchronous generator
 - 2.3 State advantages of rotating field construction
 - 2.4 State need of exciter
 - 2.5 List various types of exciters (main, pilot & static)
 - 2.6 Explain the static excitation in synchronous generator (brush less excitation)
 - 2.7 Solve problems on equation (emf of alternator)
 - 2.8 Describe measures of wave-form improvement
- 3. COMPREHEND THE PERFORMANCE, TESTING OF ALTERNATORS (SYNCHRONOUS GENERATOR).**
- 3.1 State reasons for voltage variation on load
 - 3.2 State importance of voltage regulation
 - 3.3 Define regulation of synchronous generator
 - 3.4 Define synchronous impedance
 - 3.5 State the effect of synchronous impedance on terminal voltage
 - 3.6 Draw the phasor diagram for loads at different power factors
 - 3.7 Describe O.C & S.C test on alternator
 - 3.8 Calculate regulation of 1-phase and 3-phase alternator by synchronous impedance method
 - 3.9 State the importance & drawbacks of synchronous impedance method
 - 3.10 Explain phasing of 3-ph alternator in star, delta
 - 3.11 Describe hunting
 - 3.12 Calculate regulation for different load power-factors, using synchronous impedance method.
- 4. COMPREHEND THE PROCEDURE FOR VOLTAGE CONTROL & SYNCHRONIZATION.**
- 4.1 State the necessity of parallel operation
 - 4.2 State conditions for synchronism
 - 4.3 Explain the synchronization procedure for 3-ph and 1-ph alternators using bright lamp method, dark lamp method, synchronoscope
 - 4.4 Explain method for adjusting the loads shared by two alternators or one alternator with infinite bus bar
 - 4.5 State the voltage control of alternators using Thyristor regulator
 - 4.6 Calculate the load sharing by two alternators in parallel.

LIST OF PRACTICALS

TRANSFORMERS

- 1 Study various transformers.
- 2 Determination of transformation ratio.
- 3 Determination of polarity of 1 phase transformer.
- 4 Transformer winding Project I.
- 5 Transformer winding Project I (Contd).
- 6 Open circuit test.
- 7 Short circuit test.
- 8 Determination of regulation of 1 phase transformer.
- 9 Determination of efficiency by direct loading.
- 10 Determination of efficiency by back to back test.
- 11 Parallel operation 1 phase transformer.
- 12 Study and connection of auto transformer.
- 13 Verification of current & voltage ratio of an auto transformer.
- 14 Study of 3 phase transformer & its connection.
- 15 Transformer winding project I (Contd).
- 16 Connecting 3 single phase transformer in Star-Star, & Star-Delta.
- 17 Connecting 3 single phase transformer in Delta-Delta & Delta-Star.
- 18 Connecting two 1 phase transformers in open delta & in scott.
- 19 Transformer project I (Contd).
- 20 Transformer project I (Contd).
- 21 Parallel operation, 3 phase transformers.
- 22 Connect 3-phase transformers as per given vector groups (Yy0, Dd0, Dy11, Dd6)

A.C MOTORS.

- 1 Verification of rotating magnetic field.
- 2 Study 3 phase motors.
- 3 Measuring starting & running currents of induction motor.
- 4 Study slip torque curves.
- 5 Determination of slip of stroboscope.
- 6 Connecting 3 phase motor with (a) D.O.L. (b) Auto Transformer, starters.
- 7 Connecting 3 phase motor with (a) Star-Delta starter & (b) 3 position push button starter.
- 8 Determination of efficiency of 3 phase motor.
- 9 Speed control by primary voltage control method & rotor resistance control method.
- 10 Cascade control of motor.
- 11 Starting of wound rotor motor.
- 12 Study of connection of split phase motor.
- 13 Study & connection of shaded pole motor.
- 14 Project II induction motor winding session I.
- 15 Study of repulsion motor.
- 16 Work on project II. Session II
- 17 Work on project II. Session III
- 18 Work on project II. Session IV
- 19 Work on project II. Session V
- 20 Work on project II. Session VI
- 21 Work on project II. Session VII
- 22 Work on project II. Session VIII

SYNCHRONOUS GENERATORS

- 1 Study of alternator & its operation.
- 2 Study effect of speed on frequency.
- 3 Practice alternator winding.
- 4 Practice alternator winding.
- 5 Open circuit test.
- 6 Short circuit test.
- 7 Determination of voltage regulation (synchronous impedance method).
- 8 Parallel operation of alternators by dark lamp method.
- 9 Parallel operation of alternators by bright lamp method.
- 10 Study sharing of WATTS and VARS load of two parallel-operating alternators.
- 11 Study power angle with change of load.

SYNCHRONOUS MOTORS

- 1 Study of operation as Synchronous motor.
- 2 Starting of synchronous motor using various methods.
- 3 Study effect of excitation on armature current & power factor.
- 4 Study of Torque angle with change of load.

CONVERTERS AND RECTIFIERS

- 1 Study & operate motor generator set.
- 2 Study of brushless A.C generator.
- 3 Study of servomotor.

ET-332 POWER PLANTS AND ENERGY CONSERVATION

Total Contact Hours:

Theory (only): 64

T	P	C
2	0	2

AIM: Power Generator is essential area of electrical technology. Familiarization of the types, construction, working and operation of different types of power plants is aimed at. The student should be able to see the power station as a unit, with need and working of each component integrated into the unit.

An area of growing concern covered is the energy conservation, as also an introduction to the economic aspects of electricity supply as an Industry, showing concern for investments and returns.

- 1. SOURCES OF POWER. 6 Hrs.**
 - 1.1 Introduction to different sources of power.
 - 1.2 Salient features of systems of power sources.
 - 1.3 Comparison of different sources, Thermal, Hydel, Nuclear, Solar, Tidal, Wind Magneto Dynamic and Geothermal.
 - 1.4 Solar Power System
 - 1.5 Wind Power System

- 2. THERMAL POWER STATION. 14 Hrs.**
 - 2.1 Introduction to thermal power station.
 - 2.2 Selection of fuels and site.
 - 2.3 Types of thermal power stations and their working.
 - 2.4 Parts of thermal power station and their working with schematic diagram.
 - 2.5 Boilers and their types, Water tube, fire tube etc.
 - 2.6 Steam turbines and their types, Impulse and Reaction.
 - 2.7 Construction and working principle of steam turbine.
 - 2.8 Selection and capacity of steam turbine.
 - 2.9 Construction of turbo generators.
 - 2.10 Function and application of condenser in a steam turbine power station.
 - 2.11 Water circulation system in a thermal power station.
 - 2.12 Introduction to diesel engine power station.
 - 2.13 Working of a diesel Engine, two strokes, four strokes and their comparison.
 - 2.14 Cooling system of diesel engine.

- 3. NUCLEAR POWER STATIONS. 8 Hrs.**
 - 3.1 Introduction to Nuclear power station.
 - 3.2 Main parts of nuclear power station with schematic diagram.
 - 3.3 Principle of nuclear energy, atomic structure, atomic, number (For materials mostly used for nuclear energy).

- 3.4 Kinetic energy and isotopes, fuel (Nuclear).
 - 3.5 Fission and fusion.
 - 3.6 Heavy water and its importance.
 - 3.7 Nuclear reactor, its types.
 - 3.8 Line diagram of a nuclear reactor.
 - 3.9 Nuclear power stations in Pakistan.
- 4. HYDEL POWER STATION. 12 Hrs.**
- 4.1 Introduction to Hydel Power station.
 - 4.2 Classification of Hydel Power Station.
 - 4.3 Merits & demerits of Hydel Power Station.
 - 4.4 Selection of site for Hydel Power Station.
 - 4.5 General arrangement and operation of Hydel Power Station.
 - 4.6 Types of Hydel turbines and their characteristic.
 - 4.7 Governing of Turbines.
 - 4.8 Comparison between turbines.
 - 4.9 Hydro- electric generation in Pakistan.
- 5. GAS TURBINE POWER STATION. 8 Hrs.**
- 5.1 Introduction to Gas Power station.
 - 5.2 Construction & working of simple gas turbine.
 - 5.3 Layout of a gas turbine station.
 - 5.4 Gas power station in Pakistan.
 - 5.5 Introduction to combined cycle Power station.
 - 5.6 Combined cycle power stations in Pakistan.
- 6. TARIFFS AND ECONOMICS. 8 Hrs.**
- 6.1 Introduction to economics consideration (cost of generation).
 - 6.2 Factors influencing cost of generation, load factor, demand factor, diversity factor.
 - 6.3 Different load curves.
 - 6.4 Depreciation of plant cost and method of charging.
 - 6.5 Types of Tariffs.
 - 6.6 Calculations on tariffs (simple problems).
 - 6.7 Fundamentals of load management.
- 7. CONSERVATION OF ENERGY. 8 Hrs.**
- 7.1 Introduction & necessity of energy conservation.
 - 7.2 Sources of energy loss (T&D and load) and major Items of Energy Consumption.
 - 7.3 Effect of factors on energy loss.
 - 7.4 Methods to limit losses effect of over-sized drives on losses.
 - 7.5 Methods to improve power factor in the context of energy conservation.
 - 7.6 Economical limits of PF improvement

TEXT AND REFERENCE BOOKS

1. Diesel Electric Power Plants by Kates.
2. Electrical Power by S.L Opal.
3. Elements of Power Station Design M.V. Deshpande
4. Heat Engines by K.P. Roy.
5. Nuclear Power Plants by Dr. S.M. Bhutta
6. Power Plant Technology by El-Wakil (relevant sections only)
7. Electric Power System by B.M. Weedy (Chap-I,II only)
8. Literature from ENERCON (GOP)

ET-332: POWER PLANT AND ENERGY CONSERVATION

INSTRUCTIONAL OBJECTIVES

1. KNOW DIFFERENT SOURCES OF ELECTRICAL POWER.

- 1.1 State different sources of power, (thermal, hydel, nuclear, solar, tidal, magneto hydro dynamic and wind)
- 1.2 State sources of power as Renewable and Exhaustible
- 1.3 State merits and demerits of each source (installation & working w.r.t. economics
- 1.4 State characteristics of each category of sources: Power sensitivity, environmental effects, life and life-cycle, cost, technology.
- 1.5 State the power generation as an energy conversion process, starting from the available source.
- 1.6 Impact of Indigenous and Non-Indigenous fuels on running of Power Plant
- 1.7 Introduction to solar power system
 - 1.7.1 Define solar power system
 - 1.7.2 Calculation of load for solar PV system design
 - 1.7.3 Planning for installation of solar panel up to 3 KW
 - 1.7.4 Testing of 3 KW solar system
- 1.8 Introduction to wind power system
 - 1.8.1 Define Wind Power Plant.
 - 1.8.2 Describe the role of Generator, Turbine, Blades, Gearbox, transformer, transmission lines and other Auxiliary equipment.
 - 1.8.3 Describe the schematics diagrams and symbols used in a wind power plant.

2. UNDERSTAND THE TYPES AND WORKING COMPONENTS THERMAL POWER STATION.

- 2.1 Enlist the types of thermal power stations.
- 2.2 List types of fuel used in thermal power station (Coal, Oil and Gas).
- 2.3 State requirements of site selection (cost of land, availability of abundant water, transport, load control location, climate and pollution) indicating relative weightages.
- 2.4 Explain working of a steam power plant showing parts/components on a block-diagram integrating into a unit (station)
- 2.5 Explain the parts of the steam power plant.
- 2.6 State types of boilers water tube, fire tube.
- 2.7 Describe steam turbine (Reaction, impulse).
- 2.8 Explain construction and working of a steam turbine.
- 2.9 Explain types of steam turbines.
- 2.10 Describe method of determining the capacity of a steam turbine.
- 2.11 Describe construction of a turbo generator.
- 2.12 Explain function and application of condenser in steam turbine.
- 2.13 Draw layout of water circulation system in steam power station
- 2.14 Describe diesel engine power station.

- 2.15 Compare two stroke and four stroke diesel engine.
- 2.16 Explain a diesel power station with the help of block- diagram.
- 2.17 Show schematic diagram of diesel power station.
- 2.18 State requirements of a site selection for diesel power plant (location, climatic condition, water cost of utilities, pollution etc. consideration), comparing relative weightage
- 2.19 Describe environmental effects of thermal power stations and measures to offset such hazards.

3. UNDERSTAND CONSTRUCTION AND WORKING OF A NUCLEAR POWER STATION.

- 3.1 Introduction to nuclear power station and its main parts using schematic diagram.
- 3.2 Write working principle of nuclear energy in context with atomic structure, atomic number, mass number for materials used for nuclear energy.
- 3.3 Define kinetic energy, isotope and nuclear fuel.
- 3.4 Describe fusion and fission
- 3.5 State importance of heavy water (H₃O).
- 3.6 Enlist the fissionable and fertile fuels
- 3.7 List types of nuclear reactors.
- 3.8 Describe the construction and working of a thermal Reactor
- 3.9 Explain the working of a Nuclear Station with the help of a line diagram of a nuclear power plant.
- 3.10 Describe salient features of nuclear power station working in Pakistan

4. UNDERSTAND THE TYPES, WORKING AND COMPONENTS OF HYDEL POWER STATION.

- 4.1 Enlist types of hydro- electric power stations (head of water, demand of load & quantity of water)
- 4.2 Enlist merits and demerits of hydel power stations.
- 4.3 Describe Hydel Power Stations.
- 4.4 Explain requirements of site selection for installation of hydel power plant.
- 4.5 Explain general arrangements and operation of hydel power station.
- 4.6 Describe types of hydel turbines and their characteristics.
- 4.7 Compare different hydel turbines.
- 4.8 State function of turbine components.
- 4.9 Name hydro-electric power plants working in Pakistan along with their capacities.

5. UNDERSTAND THE WORKING AND USES OF GAS TURBINE.

- 5.1 Enlist advantages and disadvantages of Gas turbine stations
- 5.2 Describe gas turbine (construction and working).
- 5.3 Sketch block diagram of a gas turbine power station.
- 5.4 List gas turbine power station working in Pakistan.
- 5.5 Describe combined cycle power station.
- 5.6 Explain combined cycle power station working in Pakistan.

5.7 Describe environmental effects of gas turbine stations and measures to improve the situation.

6. UNDERSTAND TARIFF AND ECONOMICS.

6.1 Explain effects of cost of generation (Tariff, economics).

6.2 Draw load curves.

6.3 Define load factor, demand factor, diversity factor and power plant factor.

6.4 Define type of tariff, flat rate, two part tariff, block rate tariff, maximum demand tariff, power factor and penalty tariff.

6.5 Calculate simple problem relating to tariffs and cost of generation

6.6 Describe measures to reduce cost of electricity

6.7 Define the terms: supply-side load Management and Load-side Load Management

7. UNDERSTAND METHODS OF ENERGY CONSERVATION.

7.1 Identify sources of Energy losses

7.2 Explain methods to limit energy losses (improvement of efficiency of working units, avoid over-sized drives, harmonics mitigation etc.).

7.3 Describe effects of low power factor on energy losses.

7.4 Calculate the economic limit of PF improvement for given costs/tariff

ET-345

TRANSMISSION, DISTRIBUTION AND PROTECTION OF ELECTRICAL POWER SYSTEM.

Total Contact Hours:

Theory:	128	T	P	C
Practical:	96	4	3	5

AIMS The course aims to provide understanding of the systems, constants, effects and mechanical consideration of both overhead and underground transmission and distribution lines, effects of low power factor on system performance are also included.

The 2nd half of the course is designed to provide understanding of system protection techniques, switch gear involved and protective relaying schemes. It is also aimed to provide sufficient knowledge of various solid state (Static) relays being used and the schemes of protection of generators, transformers, feeders and transmission lines.

UNIT ONE

(TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER)

- 1. BASICS OF ELECTRICAL TRANSMISSION SYSTEMS. 16 Hrs.**
 - 1.1 Components of power system.
 - 1.2 Purpose of transmission
 - 1.3 Classification of transmission lines
 - 1.3.1 With respect to voltage level (low, medium, high, extra high and ultra high voltage lines).
 - 1.3.2 Representation of power system with single line diagram showing all components of power system
 - 1.4 Comparison of different transmission systems (AC vs DC, overhead vs underground)
 - 1.5 Choice of frequency, voltage level, and supply circuits for a particular transmission line.
 - 1.6 Transmission line circuits and their comparison (radial, ring, mesh etc.)
 - 1.7 Factors effecting line cost

- 2. ELECTRICAL DESIGN OF TRANSMISSION AND DISTRIBUTION LINES 16 Hrs.**
 - 2.1 Constants of transmission lines (resistance, inductance, capacitance and conductance) of 1 phase & 3 phase (with equal spacing).
 - 2.2 Formulae (without derivations) & calculation of line constants
 - 2.3 Charging current of transmission lines and its effect, simple calculations.
 - 2.4 Classification of transmission lines based on length (short, medium and long T/Ls).
 - 2.5 Voltage drop in short transmission lines (vector diagram & simple calculations)
 - 2.6 Voltage drops in M.V. transmission lines, simple calculations using!
 - 2.6.1 T-Method, vector diagram.

- 2.6.2 Pi (π)-Method, vector diagram.
Voltage Regulation of transmission lines.
- 2.7 Effect of load on voltage. Inductive, capacitive, Surge Impedance and no-load behavior
- 2.8. Effects on transmission lines.
 - 2.8.1 Ferranti effect.
 - 2.8.2 Skin effect
 - 2.8.3 Corona effect.
 - 2.8.4 Proximity effect
- 3. **MECHANICAL COMPONENTS OF TRANSMISSION AND DISTRIBUTION LINES. 8 Hrs**
 - 3.1 Line conductors (materials and types) 2 Hrs.
 - 3.2 Line insulators (types and materials) 4 Hrs.
 - 3.3 Line supports (materials and types) 2 Hrs.
 - 3.4 Sag and its calculation 4 Hrs.
- 4. **UNDER GROUND POWER CABLES 4 Hrs.**
 - 4.1 Classification and sub classification of power cables with respect to construction (solid paper insulated and XLPE insulated cables, screened cables, oil filled cable and gas filled cables etc).
 - 1.2 Constructions and characteristics of above cables.
 - 1.3 Capacitance of single and three core cables
 - 1.4 Stress on insulation & capacitance.
 - 1.5 Laying of under-ground cables
 - 4.6 Jointing of power cables.
- 2. **POWER FACTOR CONSIDERATIONS OF TRANSMISSION LINES 6 Hrs**
 - 5.1 Causes of low power factor and its effect on generation, transmission and distribution.
 - 5.2 Importance of power factor from consumer point of view.
 - 5.3 Power factor correction methods (Static capacitors, Synchronous condensers, SVCs).
 - 5.4 Power factor improvement calculation.
- 6 **High Voltage DC Transmission (HVDC) 1 Hr.**
 - 6.1 Introduction
 - 6.2 Merits and demerits
- 7 **AC DISTRIBUTION LINES AND THEIR VOLTAGE DROP CALCULATIONS. 6 Hrs.**
 - 7.1 Calculations of AC Distributors (Voltage drop, voltage regulation, power loss, vector diagrams)

- 8. BALANCERS & BOOSTERS (A.C & D.C) 2 Hrs.**
- 8.1 Balancers-Definition.
 - 8.1.1 Types of Boosters.
 - 8.1.2 Types of Balancers.
 - 8.1.3 Uses of each.
- 9. SUB-STATIONS AND INTERCONNECTED POWER SYSTEMS. 5Hrs.**
- 9.1 Classification of sub stations (with respect to duty and construction)
 - 9.2 Describe relative merits and demerits of Indoor, outdoor and & underground substations.
 - 9.3 Equipment used in 132/11KV substation.
 - 9.4 Bus Bar arrangement schemes.
 - 9.5 Grounding of star Neutral point.
 - 9.5.1 Necessity of grounding.
 - 9.5.2 Solid grounding.
 - 9.5.3 Resistance grounding.
 - 9.5.4 Reactance grounding.
 - 9.5.5 Different sub-station schemes.
 - 9.6 Importance & advantages of Interconnected power stations.
 - 9.7 National Grid system of Pakistan.
 - 9.8 Necessity of Load management (NPCC, K-Electric/DISCOs).
 - 9.10 Gas insulated substations

** Students must prepare theory and practical note books and get it checked weekly by the concerned teacher. They should produce these to external examiner for sessional work/marking check up at the time of final examination.

**ET-345 INSTRUCTIONAL OBJECTIVES UNIT-1
(TRANSMISSION & DISTRIBUTION OF ELECTRICAL POWER)**

1. BASICS OF ELECTRICAL TRANSMISSION SYSTEMS

1.1 UNDERSTAND DIFFERENT ELEMENTS AND TYPES OF TRANSMISSION SYSTEMS.

- 1.1.1 Explain the need of electric power transmission.
- 1.1.2 Describe the difference between transmission and distribution systems.
- 1.1.3 Classify transmission systems with respect to voltage level (low V, HV, EHV and UHV).
- 1.1.4 Compare different supply systems (A.C. and D.C system. overhead and underground) along with advantages, disadvantages and specific application.
- 1.1.5 Describe schemes of connection and their comparison (radial, ring, Inter-connected system etc).
- 1.1.6 Explain effects of the followings on transmission line performance:
 - a) Supply frequency.
 - b) Supply voltages
 - c) No of conductors.
 - d) Power factor.
- 1.1.7 Explain factors effecting line cost

2. ELECTRICAL DESIGN OF TRANSMISSION AND DISTRIBUTION LINES

2.1 UNDERSTAND THE CONSTANTS AND EFFECTS OF TRANSMISSION LINES.

- 2.1.1 Explain constants of transmission lines and their effect on line performance.
- 2.1.2 Perform calculations on the constants of transmission lines.
- 2.1.3 Define charging current of AC & DC T/Ls and explain effect of charging current on transmission lines, simple calculations about charging current.
- 2.1.4 Classify transmission lines based on length (short, medium and long)
- 2.1.5 Explain voltage drop in short transmission lines (vector diagram & simple calculations)
- 2.1.6 Explain voltage drops in M.V. transmission lines, simple calculations using T & Pi (π)-Methods, along with vector diagram.
- 2.1.7 Explain voltage drop in High Voltage transmission lines using vector diagram.
- 2.1.8 Solve problems on voltage drop in short & medium transmission lines.
- 2.1.9 Enlist different effects on transmission lines (Ferranti, corona, skin and proximity etc).
 - (a) Define Ferranti effect and state its effects on transmission lines.
 - (b) Define Skin effect and its effects on line resistance.
 - (c) Explain Corona effect, its advantages and disadvantages and methods of minimizing.
 - (d) Define Proximity Effect and describe factors affecting the Proximity Effect and methods of reducing Proximity Effect).

3. MECHANICAL COMPONENTS OF TRANSMISSION AND DISTRIBUTION LINES

3.1 TYPES AND USES OF INSULATORS FOR OVER-HEAD TRANSMISSION &

DISTRIBUTION LINES

- 3.1.1 Describe the properties of different insulating materials (for overhead line insulators) and required properties of insulators.
- 3.1.2 Explain various insulators (general and special) used in overhead transmission and distribution lines.
- 3.1.3 Describe advantages of disc insulators over pin type insulators.
- 3.1.4 Compare the characteristics of strain and suspension disc insulators.
- 3.1.5 Describe methods of attaching disc insulators.
- 3.1.6 Describe factors to select No of insulators and string arrangement of insulators for a particular transmission line.

3.2 OVER-HEAD LINE CONDUCTORS.

- 3.2.1 Describe properties (Electrical, mechanical, physical and thermal) of conductors for over-head lines.
- 3.2.2 Enlist factors to be considered for selecting type and size of conductor for any transmission line.
- 3.2.3 Describe conductor materials and their characteristics used for over-head transmission and distribution lines.
- 3.2.4 Describe in detail different types of conductors (stranded, Hollow, expanded, composite (ACSR, ACAR, AACSR etc.) and bundled conductors) used in over-head lines.
- 3.2.5 Compare various line conductors.
- 3.2.7 Describe merits and demerits of different conductors.
- 3.2.8 Describe specifications of some typical ACSR conductors used in Pakistan.

3.3 POLES & TOWERS FOR TRANSMISSION AND DISTRIBUTION LINES (LINE SUPPORTS).

- 3.3.1 Describe purposes and requirements of line supports.
- 3.3.2 Describe different types of line supports with respect to!
 - a) Materials
 - b) Angle of deviation (Tangential and deviation towers (A, B, C & D Type).
 - c) No of circuits (single, double and multi)
 - d) Supporting (self supporting and guyed towers).
 - e) Base width (narrow and broad base)
- 3.3.3 Advantages & disadvantages of different line supports.
- 3.3.4 Describe factors for selecting conductor spacing
- 3.3.5 Describe vibration in overhead transmission lines conductors and its controlling methods.
- 3.3.6 Describe the purpose and types of following T/L accessories.
 - a) Vibration dampers.
 - b) Phase and danger plates
 - c) Surge arrestors (and its location)
 - d) Anti-climbing wire
- 3.3.7 Define line sag and enlist factors affecting the line sag.
- 3.3.8 Enlist effects of loose and tight sag
- 3.3.9 Drive formula for calculation of sag for equal level supports and simple calculation under normal and abnormal conditions.
- 3.3.10 Describe minimum ground clearance standards for different locations.

4. UNDER GROUND POWER CABLES

- 4.1 Classify power cables with respect to!
 - (a) Construction (solid paper insulated and XLPE insulated cables, screened cables, oil filled cable and gas filled cables etc).
 - (b) Cores
 - (c) Voltage level.
- 4.2 Describe constructions and characteristics of solid paper insulated, screened, oil and gas filled cables.
- 4.3 Describe constructions and characteristics of XLPE insulated cables.
- 4.4 Describe capacitance of single and three core cables
- 4.5 Describe methods of laying under-ground power cables.
- 4.6 Describe method of jointing power cables.

5. POWER FACTOR CONSIDERATIONS OF TRANSMISSION LINES

- 5.1 Describe causes of low power factor and its effect on generation, transmission and distribution.
- 5.2 Describe importance of power factor from consumer point of view.
- 5.3 Describe importance of power factor from supplier point of view.
- 5.4 Describe power factor correction methods (Static capacitors, Synchronous condensers, SVCs).
- 5.5 Perform power factor improvement calculation.

6. HIGH VOLTAGE DC TRANSMISSION (HVDC)

- 6.1 Introduction
- 6.2 Discuss merits and demerits of HVDC transmission
- 6.3 Describe difficulties in practical implementation of HVDC transmission

7. AC DISTRIBUTION LINES AND THEIR VOLTAGE DROP CALCULATION

- 7.1 Calculations of AC Distributors (Voltage drop, voltage regulation, power loss, vector diagrams).
- 7.2 Solve the Numerical examples of power loss in AC Distributors.

8. BALANCER AND BOOSTERS.

- 8.1 Define Balancer and booster and describe their working in DC supply system.
- 8.2 Explain the uses of Balancers and Boosters.
- 8.3 Solve simple problems of D.C balancer.
- 8.4 Discuss the working of Boosting transformer.

9. SUB-STATIONS, TYPES, COMPONENTS, GROUNDING AND INTERCONNECTED POWER SYSTEM

- 9.1 Explain the types of substations with respect to duty/function,
 - a) Step up substation.
 - b) Primary Grid substation.
 - c) Secondary substation
 - d) Distributor substations.
- 9.2 Explain the merits of indoors, outdoor and underground substations.
- 9.3 Enlist the equipment installed in a 132/11KV substation.
- 9.4 Explain various Bus Bar connection arrangements.
 - a) Single Bus Bar and Sectionalized Single Bus Bar Scheme.
 - b) Double Bus Bar.
 - c) Breaker and half scheme.
 - d) Ring bus bar scheme.
- 9.5 Describe the function of Bus Bar coupler.
- 9.6 Describe the advantages and disadvantages of each bus bar scheme.
- 9.7 Explain the necessity and advantages of neutral Point grounding.
- 9.8 Select the suitable grounding method for given system:
 - a) Solid Grounding.
 - b) Resistance Grounding.
 - c) Reactance Grounding.
- 9.9 Explain the necessity and advantages of interconnected power stations.
- 9.10 Draw the line diagram of Pakistan National Grid System of 500 KV and 220 KV,
- 9.11 Explain Gas insulated substations and compare it with conventional substations

**INSTRUCTIONAL OBJECTIVES UNIT-1
(TRANSMISSION & DISTRIBUTION OF ELECTRICAL POWER)**

Lab Assignment (Lab Report-1)

The student will visit all the workshop, administrative buildings, classes, hostel and colony etc to find out the connected load of whole the Institute/College. Students will find out the individual technologies KW load and total demand in KW, with following load factors.

Light Load-60%
 Motor Load-50%
 Welding shop load 40%

With the application of diversity factor of 0.8, students will find out the KVA Capacity required for the Institute/College along with the residential accommodations, street lights & hostels (if attached with college).

On the main switch gear side students will divide the main supply system into 3-Sub-mains and find out the

1. Main conductor size.
2. Conductor size for each technology.

This report must be submitted in 18 weeks

Lab Assignment-2

1. Visit to study sag in 11 KV distribution lines in streets, on roads, road crossings, road sides & high ways and make their sketches as per specifications of supply companies.
2. Study of various poles & towers used in distribution & transmission lines and make their sketches.
3. Study of various types of insulators used in distribution & transmission lines and make their sketches. systems and their designs.
4. Visit a substation and prepare a lay-out on the drawing sheet.

This report must be submitted in 14 weeks

UNIT -2 (Power System Protection)

- | | |
|---|----------------|
| 1. REPRESENTATION OF POWER SYSTEM BY. | 5 Hrs. |
| 11.1 One (single) line diagram, | |
| 11.2 Impedance diagram. | |
| 11.3 Reactance diagram. | |
| 11.3.1 per unit & percentage quantities. | |
| 2. FAULTS IN POWER SYSTEM. | 5 Hrs. |
| 2.1 Types of faults in power system. | |
| 2.2 Selection of Base KVA. | |
| 2.3 Calculation of percentage reactance at base KVA. | |
| 2.5 Symmetrical fault. | |
| 2.6 Short circuit capacity. | |
| 3. REACTORS IN POWER SYSTEM. | 4 Hrs. |
| 3.1 Necessity of reactors. | |
| 3.2 Construction of reactors. | |
| 3.3 Advantages and disadvantages of reactors. | |
| 3.5 Types of reactors. | |
| 3.5.1 Unshielded. | |
| 3.5.2 Magnetically shielded. | |
| 3.6 Methods of Locating Reactors. | |
| 3.6.1 Generator reactors. | |
| 3.6.2 Feeder reactors | |
| 3.6.3 Bus bar reactors. (Ring system, Tie bus bar system) | |
| 4. CIRCUIT BREAKERS. | 16 Hrs. |

- 4.1 **Need of circuit breakers in power system.**
- 4.2 **Theory of A.C Interruption**
 - 4.2.1 Phenomena of arc & its effects.
 - 4.2.2 Magnitude of arc
 - 4.2.3 Maintenance of arc and (Arc quenching) in (oil, air, gas and vacuum circuit breakers)
- 4.3 **Ratings of circuit breakers** (Normal current rating, making capacity, breaking capacity, short circuit current rating, rated voltage and operating duty)
- 4.4 **Oil circuit breakers** (working, construction, types and advantages).
- 4.5 **Air Circuit Breakers.**(Working and construction, types and advantages).
- 4.6 **SF6 Gas Circuit Breakers.**
 - 4.6.1 Dielectric, Physical& chemical properties of SF 6 Gas.
 - 4.6.2 Working & Construction of SF6 Circuit Breakers.
 - 4.6.3 AdvantagesSF6 Circuit Breakers.
- 4.7 **Vacuum Circuit Breakers.**
 - 4.7.1 Working & construction.
 - 4.7.2 Advantages.

5. ISOLATORS.

2 Hrs.

- 5.1 Types of Isolators.
- 5.2 Working principle.
- 5.3 Uses.

6. FUSES.

4 Hrs.

- 6.1 Definitions- Fuses, current carrying capacity, fusing current, prospective current & cut off current, Arcing & pre-arcing (Melting) time, total operating time, breaking capacity.
 - 6.1.1 Fuses Materials.
 - 6.1.2 Factors affecting fusing currents.
 - 6.1.3 Fusing factors.
- 6.2 Types of High voltage fuses, their construction and applications.

7. PROTECTIVE RELAYS.

12 Hrs.

- 7.1 Necessity of relaying.
- 7.2 Requirements of relaying.
 - 17.2.1 Speed.
 - 17.2.2 Selectivity.
 - 17.2.3 Sensitivity.
 - 17.2.4 Reliability.
 - 17.2.5 Simplicity.
 - 17.2.6 Economy.
- 7.3 Primary & back-up protections.
- 7.4 Classification of relays w.r.t
 - 17.4.1 Construction & Principle.

- 17.4.2 Application (Uses).
- 17.4.3 Time of operation.
- 7.5 Principle of operation.
 - 7.5.1 Buchholz's relay including its construction.
 - 7.5.2 Induction over current relay (Non directional).
 - 7.5.3 Induction reverse-power relay.
 - 7.5.4 Induction directional over current relay.
 - 7.5.5 Distance relay.
 - 7.5.6 Impedance relay.
 - 7.5.7 Beam relay.
 - 7.5.8 Frequency relay.
 - 7.5.9 Static relays (Electronic relays).
 - 7.5.10 Amplitude-comparator relays.
 - 7.5.11 Phase comparator relay.
 - 7.5.12 Static over current relay.
 - 7.5.13 Static distance relay.
 - 7.5.14 Differential protection.
 - a. Current Balance.
 - b. Voltage Balance.

- 8. BUS-BAR PROTECTION. 4 Hrs.**
 - 8.1 Bus bar protection.
 - 8.2 Frame leakage protection.
 - 8.3 Circulating current protection.

- 9. FEEDER & TRANSMISSION LINE PROTECTION. 4 Hrs.**
 - 9.1 Time Graded Protection.
 - 9.2 Differential protection.
 - 9.3 Ring mains protection.

- 10. ALTERNATOR PROTECTION. 3 Hrs.**
 - 10.1 Alternator faults.
 - 10.2 Protection against stator faults (Merz-price).
 - 10.3 Balanced Earth fault protection.
 - 10.4 Stator In-turn protection.
 - 10.5 Un-Balanced loads.

- 11. TRANSFORMER PROTECTION. 3 Hrs.**
 - 11.1 Transformers faults.
 - 11.2 Merz-price system of protection for:
 - 11.2.1 Delta-Star.
 - 11.2.2 Delta-Delta.
 - 11.2.3 Star-Delta.
 - 11.2.4 Star-Star.

11.3 Over current & Unrestricted earth fault protection.

12. LIGHTNING ARRESTERS.

2 Hrs.

- 12.1 Phenomenon (Mechanism) of lightning.
- 12.2 Effects of lightning on Electrical power system.
- 12.3 Lightning strokes.
 - 22.3.1 Direct stroke.
 - 12.3.2 Indirect strokes.
- 12.4 Protection of H.T Lines & building with ground wire.
- 12.5 Types of arrestor.
 - 22.5.1 Expulsion.
 - 22.5.2 Valve type.
 - 22.5.3 Horn gap (Rod gap) type.

**INSTRUCTIONAL OBJECTIVES, UNIT-2
(POWER SYSTEMS PROTECTION)**

1. SHORT CIRCUIT FAULT CONSIDERATIONS IN THE POWER SYSTEMS.

- 1.1 Draw the single line diagram of power system.
- 1.2 Write the formula of percentage reactance and percentage reactance at base KVA.
- 1.3 Solve the short circuit KVA at symmetrical fault (Simple Problems).
- 1.4 Solve the short circuit capacity of a Alternator in a system (Simple Problems).

2. REACTORS, NEED, TYPES AND LOCATIONS.

- 2.1 Describe the necessity of reactors in power system.
- 2.2 Describe the advantages and disadvantages of reactors.
- 2.2 Explain the type of reactors from constructional point of view.
- 2.3 Describe the location of reactors in a system (Feeder, Generator, and Bus Bar reactors (Ring system, Tie bus bar system).)
- 2.5 Draw a diagram showing the reactor in a ring system, Tie-Bar system.

3. TYPES, CONSTRUCTION AND WORKING OF CIRCUIT BREAKERS.

- 3.1 State the arc phenomena.
- 3.2 Explain the theory of A.C arc Interruption.
- 3.3 Describe magnitude of arc maintenance of arc and arc quenching in CBs.
- 3.4 Enlist type of circuit breakers and their sub types.
- 3.5 Explain working and construction of oil circuit breaker.
- 3.6 Discuss advantages and disadvantages of O.C.B.
- 3.8 Enlist types of A.C.B. and discuss advantages and disadvantages of A.C.B.
- 3.9 Explain working and construction of air circuit breaker.
- 3.10 Describe chemical, physical and dielectric properties of SF₆ gas.
- 3.11 Explain working and construction of gas circuit breaker (SF₆).
- 3.12 Enlist advantages of G.C.B.
- 3.13 Explain working and construction of vacuum circuit breaker.
- 3.14 Enlist advantages of V.C.B.

4. TYPES AND USES OF ISOLATORS.

- 4.1 Enlist types of Isolators.
- 4.2 Explain need and function of Isolators in power system.

5. FUSES IN POWER SYSTEM

- 5.1 Define the term fuse, rated current carrying capacity, fusing current, prospective current, cut-off current, pre-arcing time, arcing time, total operating time, breaking capacity
- 5.2 State fuse materials, with their characteristics.
- 5.3 Explain factors affecting the fusing current.
- 5.5 Compare advantages and disadvantages of each type.
- 5.6 Enlist types of (high voltage) fuses, describe their construction and working.

6. PROTECTIVE RELAYS

- 6.1 Explain the necessity of protective relaying.
- 6.2 Explain the requirements of relays such as!
 - a) Speed
 - b) Selectivity
 - c) Sensitivity
 - d) Reliability
 - e) Simplicity
 - f) Economy
- 6.3 Explain primary and backup protections.
- 6.4 Classify protective relays w.r.t.,
 - a) Construction and working Principle.
 - b) Applications (uses)
 - c) Time of operation.
- 6.5 Explain construction and working of Buchholz's relay.
- 6.6 Describe briefly the working and use of following relays.
 - i. Induction over current relay (directional and non directional).
 - ii. Induction reverse-power relay.
 - iii. Distance (impedance) relay.
 - iv. Balanced beam relay.
 - v. Frequency relay
 - vi. Static (Electronic) relay and its types.
- 6.7 Describe advantages and disadvantages of static relays over electromechanical relays.
- 6.8 Describe relays as comparators
- 6.9 Describe differential protection with current and voltage balance.
- 6.10 Define relay calibration and describe its need.
- 6.11 Enlist different relays tests and describe the function of each test.
- 6.12 Describe the time and current setting of relays.

7. BUS BAR PROTECTION.

- 7.1 Describe the need of bus bar protection.
- 7.2 Describe characteristics of bus bar protection system.
- 7.3 Enlist types of bus bar protection systems and describe them.
- 7.4 Describe frame leakage protection.
- 7.5 Explain circulating current protection.

8. FEEDER AND TRANSMISSION LINES PROTECTION.

- 8.1 Discuss feeder protection and describe unit and non unit type protection group.

- 8.2 Enlist types/methods of feeder protection
- 8.3 Explain types of feeder protection
 - a) Time graded over current protection.
 - b) Current graded over current protection.
 - c) Pilot wire differential protection (circulating current system, Translay differential system, balance voltage system).
 - d) Ring main protection.

9. ALTERNATOR PROTECTION.

- 9.1 Enlist and describe all types of alternator faults.
- 9.2 Explain over load, over current and over voltage protection of alternators.
- 9.2 Explain Merz-Price systems of alternator protection.

10. TRANSFORMER PROTECTION.

- 10.1 Enlist and describe transformer faults.
- 10.2 Describe transformer protection schemes/arrangements.
- 10.3 Describe Merz-Price system of transformer protection and draw connection diagram for Star-Delta, Star-Star, Delta-Star and Delta-Delta .
- 10.4 Explain over current and unrestricted earth faults protection schemes.

11. LIGHTNING AND LIGHTNING ARRESTOR.

- 11.1 Explain phenomena of Lightening.
- 11.2 Describe effect of lightening on electrical power system.
- 11.3 Describe types of lighting strokes and protection of T/L from them.
- 11.4 Describe protection of HT lines and buildings with the help of ground wires.
- 11.5 Define lightning/Surge arrester and enlist its types.
- 11.6 Explain the construction and working of Expulsion type, Valve type and horn gap type lightening arrestors.

LIST OF PRACTICALS, UNIT-2
(POWER SYSTEM PROTECTION)

- 1 Study of different types of relays through industrial/substation visit(s), make their sketch to understand their working and prepare a report of visit. Also prepare report about techniques of setting various relays on the front panels.**
 - 1.1 Buchholz's relay.
 - 1.2 Induction over current relay.
 - 1.3 Induction reverse power relay.
 - 1.4 Impedance relay.
 - 1.5 Frequency relay.
 - 1.6 Static relays.
- 2. Study of various protective schemes employing protective relays through industrial/substation visit and prepare report about them.**
- 3. Visit to study calibration of electro-mechanical and static relays using calibrating equipment.**
- 4. Study of protection schemes used for Alternators protection, Transformer protection, in a power house/grid station through industrial/substation/power house visit and prepare report about them.**
- 5. Visit to Study the Mechanical Designs, Operation and maintenance procedures for various types of circuit breakers, isolators, and lightning arrestors.**

Note: All the reports, assignments must be submitted within two weeks after visit to the teacher concerned and should be presented to the external examiner for final assessment during final practical test.

Recommended Books (for both units):

1. Transmission & Distribution by TuranGonen.
2. Electrical Power System by C.L. Bhadwa.
3. A Course in Electrical Power by Soni Gupta.
4. Electrical Power by SL Uppal.
5. Construction Practice of Substations in India by R. Sabal.
6. Principles of Power System By V. K. Mehta and Rohit Mehta, S. Chand and Co. India .
7. Electrical power transmission and distribution by S.Sivanagaraju, Pearson education ,Delhi, India.
8. power transmission and distribution of electrical power by U.A Bakshi and M.V Bakshi, Technical Publications ,Pune, India.
9. Switchgear and Protection by U.A Bakshi and M.V Bakshi, Technical Publications ,Pune, India.
10. Switchgear and Protection by Sunil S.Rao. S.Chand and Co.

ET- 303 TELECOMMUNICATION**Total Contact Hours**

Theory	64	T	P	C
Practical	96	2	3	3

AIM Based on sound principles of electrical and electronics engineering, this area has become the back bone of present-day economy. Knowledge of state-of-the-art equipment and practices such as digital communication have been included in this course.

COURSE CONTENTS

1	TELEPHONY	6 Hrs.
	1.1 Block diagram of a telephony system	
	1.2 Telephone network	
	1.3 Basic structure of a PSTN	
2	DIFFERENT TYPES OF NETWORKS	6 Hrs.
	2.1 Mobile Networks	
	2.2 Cable TV Networks	
	2.3 Interconnection of Networks	
	2.4 Internet	
	2.6 Access to the Network	
	2.7 Specialist Networks Associated with PSTN	
	2.8 Model Set of Telco Networks	
1	NETWORK COMPONENTS	6 Hrs.
	1.1 Network Topologies	
	1.2 Switching: Concentrator, Route and Packet	
	1.3 Control	
	3.4 Multiplexing	
	1.5 Grooming and Consolidating	
	3.6 Link Components of Network	
	3.7 A/D conversion	
2	TRANSMISSION SYSTEMS	6 Hrs.
	2.1 Transmission Principles and Media	
	2.2 Multiplexed Payloads	
	2.3 Range of Transmission Systems	
5	TRANSMISSION NETWORKS	8 Hrs.
	5.1 Access Networks	
	5.2 Core Transmission Networks	
6	CIRCUIT SWITCHING NETWORKS AND SYSTEMS	8 Hrs.
	6.1 Circuit Switching Systems	
	6.2 Network Dimensioning	
7	SIGNALLING AND CONTROL	4 Hrs.
	7.1 Signaling and ITU Protocols	
	7.2 Control of Telecommunication Networks	
8	DATA and PACKET SWITCHING NETWORK	10 Hrs.
	8.1 Packet Switching and Concept of Data	
	8.2 Internet and VoIP Networks	
	8.3 Local Area Networks	
	8.4 Data Services	

9	MOBILE SYSTEMS AND NETWORKS	10 Hrs.
9.1	Characteristics of Mobile Networks	
9.2	Cellular Networks and Access	
9.3	GSM System and GPRS	
9.4	Fourth Generation Mobile Systems – LTE	
9.5	Multi-Generation Mobile Systems	

INSTRUCTIONAL OBJECTIVES**1 FUNDAMENTALS OF TELEPHONY**

- 1.1 Describe the building blocks of a telephony system and describe its components
- 1.2 Describe the telephone network components and the role of local, trunk and international exchanges
- 1.3 Explain the structure of a Public Switched Telephone Network (PSTN)

2 DIFFERENT TYPES OF NETWORKS

- 2.1 Describe the need for various types of networks in a country and the need for them to interconnect.
- 2.2 Explain the different components that make up Mobile Networks and Cable TV Networks
- 2.3 Explain the Interconnection of Networks in the Public Network Operators (PNOs) e.g. in making international calls or mobile-to-mobile calls
- 2.4 Explain the concept of Internet as the largest data network with need for Internet Protocol (IP)
- 2.6 List the various ways to access the Internet including dial-up via PSTN and ISDN, over ADSL and vDSL broadband link, cable modem, optical fiber, leased line and mobile network
- 2.7 List the different specialist networks associated with PSTN including Operator-Services Network, Intelligent Network, Business Services Network, Leased Line Services Network, Data Services Network and Telex Network.
- 2.8 List diagrammatically a model set of Telco Networks

1 NETWORK COMPONENTS

- 1.1 Describe the different types of network topologies like Star, Ring, Mesh, Grid and Delta.
- 1.2 Explain the need for different levels of Switching: Concentrator, Route and Packet
- 1.3 Explain the need for Control implemented on the networks using computer processing and storage
- 1.4 Explain the need for multiplexing to allow carriage of various tributary streams over a high capacity bearer.
- 1.5 List different types of multiplexing like Frequency-Division Multiplexing (FDM), Time-Division Multiplexing (TDM) and Code-Division Multiplexing (CDM)
- 1.6 List the need for Grooming and Consolidating to better manage the network
- 1.7 Explain the role of different link components of a Network including Transmitter, Receiver and Transmission Medium
- 1.8 List the advantages of digital communication and explain the working and role of A/D conversion

2 TRANSMISSION SYSTEMS

- 2.1 Explain the need and basics of different modulating schemes like Amplitude Modulation (AM), Frequency Modulation (FM) and Phase Modulation (PM) for analog signals and digital modulation techniques such as PAM, PPM and PCM.
- 2.2 Explain the need and basics of carrier modulation such as Pulse Shift Keying (PSK) and Frequency Shift Keying (FSK).
- 2.3 List and Describe the role of different transmission media for communication such as Copper Pair Cable, Optical Fiber Cable, Coaxial Cable, Free Atmosphere Transmission and Free Space Transmission via satellites.
- 2.4 Describe the role of multiplexing in optimizing the communication infrastructure.
- 2.5 Explain the range of different transmission systems such as Metallic Line, different types of Digital Subscriber Line, Point-to-Point Optical Fiber Line, Dense Wave Division Multiplex System, Passive Optical Fiber such as APON, BPON, EPON and GPON, Ethernet Fiber, Dark Fiber, Submarine Cable, Line-of-Sight Microwave Links, Earth Satellite Systems, WLAN and

Wireless Metropolitan Systems.

5 TRANSMISSION NETWORKS

- 5.1 Describe the use of Access Networks to interconnect end-user subscriber to the Network
- 5.2 Explain the Access Network structure and block diagram of Local Loop
- 5.3 Explain the Access Network structure and block diagram of Optical Fiber including direct fiber to premises, passive optical network delivery and hybrid copper-fiber telephony.
- 5.4 Explain the Access Network structure and block diagram of Radio Links including Fixed Line-of-Sight, Wireless LAN and WiMAX.
- 5.5 Explain the Access Network structure and block diagram of Broadband options
- 5.6 Describe the future of fixed line telephony
- 5.7 Describe the use of Core Transmission Networks to interconnect small number of Network Nodes spread across geography at the higher level.
- 5.8 Explain the Core Transmission Network structure and block diagram of PDH Network
- 5.9 Explain the Core Transmission Network structure and block diagram of SDH Network
- 5.10 Explain the Core Transmission Network structure and block diagram of Carrier Ethernet Backhaul Links.
- 5.11 Describe the concepts of Transmission Network Resilience

6 CIRCUIT SWITCHING NETWORKS AND SYSTEMS

- 6.1 Describe the structure and hierarchy of Circuit Switching Systems with Fixed Network (Wireline) Exchanges.
- 6.2 Explain the working of Subscriber Switching Units
- 6.3 Explain the working of Digital Telephone Switching Systems
- 6.4 Explain the structure of Digital Exchanges
- 6.5 Explain the structure of Integrated Services Digital Network Exchanges (ISDNs)
- 6.6 Explain the structure of Non-Subscriber Digital Switching Units such as MSC and Fixed Network Tandem Units
- 6.7 Describe the concepts of Switched Traffic
- 6.8 Explain the process of Call Distribution
- 6.9 Explain the concepts of Traffic Flow and Traffic Routing
- 6.10 Describe the basics of Exchange Capacity Planning

7 SIGNALLING AND CONTROL

- 7.1 Describe the basics of Signaling and its domains in a communication Network
7.2 Signaling System SS7, H323 and SIP
- 7.3 Describe the basics of Network Control applied to Setting-Up, Monitoring and Call Control.
- 7.4 Explain the structure of Exchange Control Systems
- 7.5 Explain the structure of IP Multimedia Sub-System

8 DATA and PACKET SWITCHING NETWORK

- 8.1 Describe the concepts of Packet Switching and Data for connection-oriented and connectionless modes and compare the two modes
- 8.2 Describe the concepts of Internet Protocol, Internet as a Utility and VoIP Networks
- 8.3 Describe the block diagram and concepts of Local Area Networks
- 8.4 List the data services provided by Telcos

9 MOBILE SYSTEMS AND NETWORKS

- 9.1 Explain the characteristics of Mobile Networks and its block diagram of Mobile System
- 9.2 Explain the basics of how a radio works
- 9.3 Describe the structure of Cellular Networks and its Access mechanisms
- 9.4 List the basic features and background of GSM System and GPRS
- 9.5 List the basic features and background of third generation mobile systems – 3G

- 9.6 List the basic features and background of Fourth Generation Mobile Systems – LTE
- 9.7 List the basic features and background of Multi-Generation Mobile Systems

LIST OF PRACTICALS

96 hours

- 1 Study the electro-mechanical telephone set and draw its block diagram
- 2 Observe electro-mechanical telephone exchange switching system
- 3 Study generation of double side band AM with carrier present or suppressed
- 4 Demodulation of double side band modulation with carrier
- 5 Observe frequency modulated carrier and measurement of frequency component when carrier is modulated by sinusoid
- 6 Observe demodulation by an FM detection circuit
- 7 Study of antennas
- 8 Visit of Radio Station/Media House to study transmission feeds and infrastructure
- 9 Study of demodulation of binary coding of dc input levels for 3, 4 and 8-bit words in PCM
- 10 Investigate effects of sampling and TDM on analog wave form
- 11 Measurement of analyzing signal-to-noise in TDM
- 12 Demonstrate channel switching
- 13 Visit to a digital telephone exchange to study Main Distribution Frame (MDF), DSLAM, etc.
- 14 Visit to Cable TV operator to study the infrastructure for DOCSIS triple-play services
- 15 Study power & current of LED
- 16 Determine fiber-photodiode coupling efficiency
- 17 Determine Fiber-Fiber coupling efficiency
- 18 Study digital transmission by fiber optics
- 19 Study analog transmission of fiber optics
- 20 Draw block diagram of PCM based PABX
- 21 Visit microwave station
- 22 Study satellite receiving stations
- 23 Study a satellite receiving system
- 24 Study/Visit a center of a mobile service provider, providing GSM and GPRS services
- 25 Study/Visit a center of a mobile service provider, providing 3G services
- 26 Study/Visit a center of a mobile service provider, providing 4G-LTE services
- 27 Visit BTS tower

RECOMMENDED BOOKS.

- 1 Understanding Telecommunications Networks by Andy R Valdar, The Institution of Engineering and Technology 2nd Edition (2017)
- 2 The Essential Guide to Telecommunication by Annabel Z. Dodd, Prentice Hall (2019)

ET-363 REPAIR AND MAINTENANCE OF ELECTRICAL EQUIPMENT

Total Contact Hours		T	P	C
Theory	32	1	6	3
Practical	192			

- AIMS**
1. Understand different faults in Electrical Equipment, Machines and Appliances.
 2. Undertake repair work on various electrical appliances and equipment safely.
 3. Schedule routine and preventive maintenance for a given installation.

COURSE CONTENTS

- 1 FUNDAMENTALS OF ELECTRICAL MAINTENANCE. 3 Hrs.**
 - 1.1 Scheduled maintenance and preventive maintenance
 - 1.2 Minor repairs
 - 1.3 Major repairs, overhauls
 - 1.4 Tools and Equipment used for repair work.
 - 1.5 Safety rules to be observed during repair work
 - 1.6 Risk Assessment
 - 1.7 Role of AVR in fault prevention
- 2 COMMON FAULTS OF STARTERS AND SPEED CONTROLLERS. 3 Hrs.**
 - 2.1 Direct on line magnetic starter
 - 2.2 Star Delta Starter (Manual and Automatic)
 - 2.3 Inverter
 - 2.4 DC drives
 - 2.5 Speed controllers for D.C. motors.
- 3 FAULTS, THEIR CAUSES AND REMEDIES OF A.C. 3 PHASE MOTORS. 4 Hrs.**
 - 3.1 Squirrel Cage Induction motor
 - 3.2 Wound Rotor Induction motor
 - 3.3 Synchronous motor
- 4 FAULTS THEIR CAUSES AND REMEDIES OF SINGLE PHASE A.C. MOTORS. 3 Hrs.**
 - 4.1 Split phase motors (capacitor start and capacitor run motors)
 - 4.2 Universal motors
 - 4.3 Synchronous motors.
- 5 DIRECT CURRENT MOTORS; THEIR FAULTS, CAUSES AND REMEDIES 4 Hrs.**
 - 5.1 D.C. series motor

- 5.2 D.C. shunt motor
- 5.3 D.C. compound motor.

- 6 **DIRECT CURRENT GENERATORS THEIR FAULTS, CAUSES AND REMEDIES.** **3 Hrs.**
 - 6.1 D.C. series generator
 - 6.2 D.C. shunt generator
 - 6.3 D.C. compound generator.

- 7 **FAULTS, THEIR CAUSES AND REMEDIES OF ALTERNATORS.** **2 Hrs.**
 - 7.1 3 phase salient pole type
 - 7.2 3 phase non salient pole type (Smooth Cylindrical type)

- 8 **FAULTS THEIR CAUSES AND REMEDIES OF TRANSFORMERS.** **3 Hrs.**
 - 8.1 3 phase power transformer oil cooled
 - 8.2 Air cooled transformers, 1-phase and 3-phase
 - 8.3 Auto transformer

- 9 **FAULT THEIR CAUSES AND REMEDIES OF HOUSE HOLD APPLIANCES.** **5 Hrs.**
 - 9.1 Automatic Electric Iron
 - 9.2 Toaster
 - 9.3 Refrigerator
 - 9.4 Air conditioner (Window, Split & Invertor)
 - 9.5 Washing Machine
 - 9.6 Microwave oven and induction cooker
 - 9.7 UPS

- 10 **BATTERIES, THEIR FAULTS, CAUSES AND THEIR REMEDIES.** **2 Hrs.**
 - 10.1 Lead Acid Battery
 - 10.2 Alkaline Battery
 - 10.3 Lithium Ion batteries
 - 10.4 Safety for handling batteries

RECOMMENDED BOOKS:

1. Repair and Maintenance of Electrical Equipment by Stafford.
2. Testing and Connecting D.C. Motors by Annet.
3. Repair of Electrical Appliances by A.I.O.U.

ET-363 REPAIR AND MAINTENANCE OF ELECTRICAL EQUIPMENT

INSTRUCTIONAL OBJECTIVES

- 1 UNDERSTAND THE NEED AND TYPES OF MAINTENANCE OF ELECTRICAL EQUIPMENT.**
 - 1.1 Compare routine maintenance, preventive maintenance and general overhaul
 - 1.2 Understand the terms associated with maintenance e.g. breakdown, MTTR (Mean Time to Restore) MTBF (Mean Time between Failure), Downtime percentage.
 - 1.3 Explain maintenance schedule and differentiate between minor and major repair
 - 1.4 Enlist the tools and instruments necessary for an electrical maintenance shop
 - 1.5 Sketch the single line diagram of maintenance shop
 - 1.6 Enlist & discuss methods of Risk Assessment
 - 1.7 Discuss the role of AVR in fault prevention

- 2 APPLY THE KNOWLEDGE ABOUT THE FAULTS, CAUSES AND REMEDIES OF MOTOR STARTERS AND CONTROLLERS.**
 - 2.1 Identify the parts of a Direct on line magnetic starter, star delta starter (Manual & Automatic)
 - 2.2 Describe the parts of DC Drivers, soft starters, Invertors and VFD.
 - 2.3 Explain the faults, their causes and remedies of DC Motor drivers and controllers.

- 3 UNDERSTAND FAULTS, CAUSES AND REMEDIES OF A.C. 3-PHASE MOTORS.**
 - 3.1 Enlist the faults their causes and remedies of squirrel cage 3 phase A.C. motor and wound rotor motor.
 - 3.2 Identify the faults, their causes and remedies of 3 phase synchronous motor.
 - 3.3 Explain common tests to locate faults in A.C. motors stators.
 - 3.4 State the mechanical faults in A.C. motors.

- 4 APPLY THE KNOWLEDGE OF THE FAULTS, CAUSES AND REMEDIES OF A.C. SINGLE PHASE MOTORS.**
 - 4.1 Explain the faults, causes and remedies of single phase capacitor start motors.
 - 4.2 Explain the faults, causes and remedies of single phase capacitor run motors.
 - 4.3 Explain the faults, causes and remedies of universal motors.
 - 4.4 Prepare the list of faults, causes and remedies of single phase synchronous motors.

- 5 UNDERSTAND THE FAULTS, CAUSES AND THEIR REMEDIES OF D.C. MOTORS.**
 - 5.1 Explain the various tests to be carried out for locating the faults in armature.
 - 5.2 Enlist the faults, causes and remedies of series, shunt and compound motors.

- 6 UNDERSTAND THE FAULTS AND REMEDIES OF D.C. GENERATORS.**
 - 6.1 Describe the causes of failure of the building up process in D.C. Generator.

6.2 Explain the methods for control of armature reaction in D.C. machines.

6.3 Explain the fault, causes and remedies of D.C. generators.

7 UNDERSTAND FAULTS, CAUSES AND REMEDIES OF ALTERNATORS.

7.1 Explain the effect of speed and weakening of main magnetic field on emf of an alternator.

7.2 Prepare list of faults, causes and remedies of Brushless alternators.

7.3 Enlist the common faults of salient and cylindrical rotor alternators.

8 UNDERSTAND THE FAULTS, CAUSES AND THEIR REMEDIES OF TRANSFORMER.

8.1 Explain the methods of testing transformer oil and its reconditioning.

8.2 Explain the test of presence of moisture in silica gel and its drying method.

8.3 Identify the faults, causes and remedies of three phase power transformer.

8.4 Enlist the faults and remedies of on load and off load tap changer.

9 UNDERSTAND THE FAULTS AND THEIR REMEDIES OF HOUSE HOLD APPLIANCES.

9.1 Explain the function of thermostat and its faults in an electric iron.

9.2 Enlist the general faults and their remedies of automatic electric iron.

9.3 Enlist the major faults in fans and their remedies.

9.4 State the common faults with causes in Refrigerators and Air conditioners and their remedies.

9.5 Explain the faults in components of a washing machines and their rectification.

9.6 State the faults in microwave oven, induction cooker and their remedies.

9.7 Explain the faults and their remedies in electric water heaters.

9.8 Explain the common defects and their remedies in kitchen appliances.

9.9 Explain the common defects and remedies in UPS

10 UNDERSTAND THE MAJOR FAULTS, CAUSES AND THEIR REMEDIES OF ACCUMULATORS.

10.1 Explain the method of preparing and checking gravity of an electrolyte.

10.2 Describe the different methods of battery charging.

10.3 Explain the faults, causes and remedies of lead acid, alkaline batteries and BMS (Battery Management System) of Lithium ion batteries.

ET-363 REPAIR AND MAINTENANCE OF ELECTRICAL EQUIPMENT

LIST OF PRACTICALS

- 1 Draw the Layout of Repair shop and also prepare a safety chart.
- 2 Prepare the list of tools and equipment used in Electrical repair shop.
- 3 Rewind and replace a hold-on coil of D.C. Motor Starter. This should include Varnishing & baking of coil. Also Polish the contact points of the starter and perform its general maintenance. Maintenance of timers/over load relays installed in starters should also be done.
- 4 Repair & general overhauling and maintenance of
 - 4.1 Direct on the line starter
 - 4.2 Star Delta starter
 - 4.2.1 Non automatic
 - 4.2.2 Automatic
 - 4.3 Auto transformer starter
 - 4.3.1 Non Automatic
 - 4.3.2 Automatic
 - 4.4 Electronic Motor starters
 - 4.4.1 DC drive
 - 4.4.2 Soft Starters
 - 4.4.3 Invertors
 - 4.4.4 VFD
 - 4.5 AVR
- 5 Pull out a bearing of a motor and replace it after cleaning and greasing.
 - 5.1 Replace a bush bearing.
- 6 Polarity testing of stator winding of a 3 phase motor i.e. no of poles/phase and their position.
- 7 Repair, over hauling and maintenance of
 - 7.1 Three phase squirrel cage induction motors.
 - 7.2 Three phase wound rotor induction motors.
 - 7.3 Three phase synchronous motor induction motors.
 - 7.4 Single phase capacitor start.
 - 7.5 Single phase capacitor run motor.
 - 7.6 Single phase shaded pole motor.
 - 7.7 Single phase universal motor.
 - 7.8 Single phase synchronous motor.
 - 7.9 Rewinding of single phase motor / ceiling fan motor
 - 7.10 Rewinding of three phase Squirrel cage motor
- 8 Repair, overhauling and maintenance of DC motors and generators.
 - 8.1 Polarity marking of D.C. Motor/Generator.
 - 8.2 Repair and Polishing of D.C. commutator, replacement of carbon brush.
 - 8.3 General overhauling and maintenance of
 - 8.3.1 D.C. Motors

- 8.3.2 D.C. generators
- 8.4 Armature and field winding testing by Growler.
- 9 Test the sample of oil by:
 - 9.1 Oil Tester
 - 9.2 Copper Sulphate
- 10 Take out the silica gel from an oil cooled transformer and recondition it.
- 11 Recondition the oil of a transformer.
- 12 General repair and over hauling of oil cooled transformer.
- 13 Testing & calibrating an energy meter
- 14 Repair, over hauling, maintenance and assembling of
 - 14.1 Electric Iron
 - 14.2 Pedestal Fan
 - 14.3 Ceiling Fan
 - 14.4 Kitchen Grinder
 - 14.5 Juicer
 - 14.6 Water Heater
 - 14.7 Microwave Oven & Induction Cooker
 - 14.8 Air Conditioner (Conventional, Split & inverter)
 - 14.9 Refrigerator
 - 14.10 UPS
- 15 Maintenance of Lead Acid
 - 15.1 Preparation of Electrolyte for Battery charging.
 - 15.2 Charging a Battery with
 - 15.2.1 Constant current method
 - 15.2.2 Constant voltage method
 - 15.3 Identification of faulty cells

ET-373

INDUSTRIAL ELECTRONICS

Total Contact Hours:

Theory	64
Practical	96

T	P	C
2	3	3

AIM:

As the application of solid state electronics in the control of electrical systems is increasing rapidly, the 2nd half of this course provides reasonable knowledge of power electronics including control of AC/DC motors, synchro-servo system etc. concepts and applications of Programmable Logic Controllers (PLC) have also been included.

- 1. POWER DIODES & THYRISTORS. 8 Hrs.**
 - 1.1 Construction, ratings and characteristics of power diodes
 - 1.2 Series & parallel operation of power diodes
 - 1.3 Review of SCR, its characteristics
 - 1.4 SCR phase control
 - 1.5 Series & parallel operation of SCR's
 - 1.6 IGBT as a switch, its characteristics and operation through gate drivers

- 2. CONTROLLED RECTIFIERS (1-PHASE & 3-PHASE) 10 Hrs.**
 - 2.1 Basic controlled rectifier circuits
 - 2.2 Forced commutated controlled rectifier circuit (1-Phase & 3-Phase)
 - 2.3 Naturally commutated controlled rectifier circuit (1- Phase & 3-Phase)

- 3. INVERTERS. 10 Hrs.**
 - 3.1 1-Phase full-wave inverter circuit
 - 3.2 3-phase full-wave bridge circuit as a line-commutated inverter
 - 3.3 Four quadrant control

- 4. CONTROL OF DC & AC MOTORS. 12 Hrs.**
 - 4.1 DC motor speed control system
 - 4.2 3-phase full-wave controlled rectifier circuit to control DC motors
 - 4.3 1-phase full-wave controlled rectifier circuit to control DC motor
 - 4.4 Introduction to speed control of induction motors
 - 4.5 SCR cyclo-converter.
 - 4.6 Open-loop & closed-loop induction motor speed control.

- 5. SYNCHRO-SERVO SYSTEMS. 8 Hrs.**
 - 5.1 Synchro-generator and synchro-motor
 - 5.2 Differential synchro
 - 5.3 AC & DC servo-mechanism
 - 5.4 Servo motors, characteristics & uses

6. PROGRAMMABLE LOGIC CONTROLLER

(Dedicated PLC's.)

8 Hrs.

6.1 Introduction to PLC's

6.2 ladder logic inputs, ladder logic outputs, symbols

6.3 Input and output modules

6.4 Relays, Timers and counters

6.5 Modes of operation

6.6 Ladders and Rungs

6.7 Multiple contacts

6.8 Use of A/D and D/A converters

6.9 Programming and operation of simple motor control circuits for given ladder logic.

(Computer Software Control.)

8 Hrs.

6.10 Ladder relay instructions

6.11 Ladder timer instructions

6.12 Ladder counter instructions

INSTRUCTIONAL OBJECTIVES

- 1 UNDERSTAND THE WORKING OF POWER DIODES, THYRISTORS and IGBTs.**
 - 1.1 State the ratings of power diodes and SCR.
 - 1.2 Explain characteristics of power diodes
 - 1.3 Explain the series & parallel operation of power diodes. Discuss the challenges of parallel operation.
 - 1.4 Draw and explain characteristics of SCR.
 - 1.5 Describe the phase control and resulting output of SCR.
 - 1.4 Explain series & parallel operation of SCRs.
 - 1.6 Draw and explain the characteristics of IGBTs
 - 1.7 Describe the Gate Drives required for low side and high side switching of IGBTs.

- 2. UNDERSTAND THE OPERATION OF PHASE CONTROLLED RECTIFIERS & CONVERTERS, WITH THE HELP OF CIRCUIT AND WAVE DIAGRAMS.**
 - 2.1 State various methods of phase control for SCRs.
 - 2.2 Explain with the help of circuit and wave diagrams the operation of controlled rectifier.
 - 2.3 Explain the natural commutation and forced commutation in 3-phase and 1-phase rectifiers.
 - 2.4 Explain the operation of half and full-wave naturally commutated converters.

- 3. UNDERSTAND SINGLE AND THREE PHASE FULL-WAVE CONVERTER/INVERTER.**
 - 3.1 Draw circuit for 1-phase and 3-phase full-wave inverter circuit.
 - 3.2 Explain the working of inverter circuit (1-phase & 3-phase)
 - 3.3 Explain the line commutated (single and three phase) inverter with full-wave output.
 - 3.4 Know the combined operation of rectifier and inverter as four quadrant control of a converter.

- 4. UNDERSTAND THE USE OF POWER ELECTRONICS FOR CONTROL OF A.C./D.C. MOTORS - UNDERSTAND THE USE OF DIODES & SCRs CONNECTED FOR 1-PHASE & 3-PHASE, FOR SPEED CONTROL OF D.C. MOTORS.**
 - 4.1 State the methods of speed control of DC motors.
 - 4.2 Explain the speed control of DC motors employing 3-phase full-wave controlled rectifier circuits.
 - 4.3 Describe the speed control of DC motors employing 1-phase fully controlled rectifier circuit, with the help of circuit and waveform.
 - 4.4 Draw circuit for a 3-phase fully phase controlled, 4-quadrant speed control of DC

motors.

5. UNDERSTAND USE OF POWER ELECTRONICS FOR CONTROL OF AC MOTORS.

- 5.1 State methods of AC Motors Control.
- 5.2 Draw circuit, and waveform for 3-phase AC variable output voltage employing semi-conductor devices.
- 5.3 Draw block diagram and waveform for cyclo-converters giving 1-phase and 3-phase variable frequency output.
- 5.4 State the use of SCR cyclo-converters for speed control of AC motors.
- 5.5 Draw and explain the open-loop speed control of electric motors.
- 5.6 Draw and explain the closed-loop speed control of motors.

6. UNDERSTAND WORKING AND USES OF SERVO AND SYNCHRO SYSTEMS.

- 6.1 Define synchro-generator, synchro motor, types of synchro-servo mechanism.
- 6.2 Draw and explain diagram showing use of synchro-generator and synchro-motor.
- 6.3 Describe the differential synchros.
- 6.4 Draw and explain block and circuit diagrams for AC and DC systems of servo mechanism.
- 6.5 Explain characteristics and industrial applications of servo-motors.

7. UNDERSTAND THE USE OF PLC'S FOR A GIVEN LADDER-LOGIC CONTROL.

- 7.1 Describe the architecture of PLC's
- 7.2 Explain the uses of PLC in industrial control
- 7.3 Define the terms: ladder logic, input logic output of PLC's.
- 7.4 Write the codes for the input-output devices for a given logic.
- 7.5 Explain the various modes of operation for PLC's.
- 7.6 Converts the given ladder logic diagram of a control problem into its components as inputs, outputs, logic elements & numbering the logic elements.
- 7.7 Explain the method for sequencing multi-rung circuits into sequenced sections for additional capacity of PLC.
- 7.8 Explain the use of A/D & D/A converter for use along with a given ladder logic diagram.
- 7.9 Explain the use of timers, sequential registers and other multi-contact logic devices.

8. UNDERSTAND USE OF COMPUTER SOFTWARE FOR LADDER LOGIC CONTROL.

- 8.1 Write ladder instructions for relay logic.
- 8.2 Write ladder instructions for timer logic.
- 8.3 Write ladder instructions for a counter logic.

LIST OF PRACTICALS

1. Study the characteristics and series-parallel working of power diodes
2. Demonstrate SCR phase control
3. Observe the characteristics & working of forced commutated controlled-rectifier circuits
4. Observe the characteristics and working of naturally commutated full-wave convertors
5. Construct and study working of 1-phase full-wave inverter circuit
6. Construct and study working of 3-phase full-wave inverter
7. Study 3-phase full-wave control circuit for DC motors
8. Study working of AC to AC converters as AC motor speed controller
9. Study working of SCR cyclo-converter
10. Study open & closed loop induction motor speed control
11. Study characteristics and working of synchro-generator and synchro-motors
12. Study characteristics & working of servo-motors.
13. Study of given process and development of ladder diagrams
14. Developing software for a given ladder diagram and inputting it
15. Application of PLC to practical control applications
16. Introduction to SIEMENS PLC LOGO for industrial use like water tank, air compressor pressure maintaining, vending machine, automatic electrical switching etc.
17. Use of computer software for practical control applications.
18. Prepare project to demonstrate application of industrial electronics and control – 4 weeks
 - 18.1 Design the project
 - 18.2 Implementation on bread board
 - 18.3 Implementation on PCB

REFERENCE BOOKS

- 1 Power Electronics by B.W. Williams
- 2 Power Electronics & Controls, Samir Datta
- 3 Trade Literature on PLC and their Applications
- 4 Electronics in Industry by Chute
- 5 Allen Bradley: Mini-Programmable Controllers Programming and Operation Manual
- 6 Programmable Logic Controllers by Mike Birmingham and Keith Brown
- 7 Fundamentals of industrial electronics by Bogdan M. Wilamowski, J. David Irwin – 2nd edition – 2011
- 8 Introduction to Modern Power Electronics by Andrezej M. Trzynadlowski, 3rd Ed., 2016