K S Institute of Technology, BANGLORE

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

COURSE FILE

NAME OF THE STAFF	**: VISHALINI DIVAKAR**
SUBJECT CODE/NAME	**: 18ELE23-BASIC ELECTRICAL ENGG.**
SEMESTER/YEAR	**: I YEAR/II SEM(D,E)**
ACADEMIC YEAR	**: 2020 – 2021**
BRANCH	**: ECE(D,E)**

COURSE IN-CHARGE

HOD

K. S. INSTITUTE OF TECHNOLOGY

VISION

"To impart quality technical education with ethical values, employable skills and research to achieve excellence".

MISSION

- To attract and retain highly qualified, experienced & committed faculty.
- To create relevant infrastructure.
- Network with industry & premier institutions to encourage emergence of new ideas by providing research & development facilities to strive for academic excellence.
- To inculcate the professional & ethical values among young students with employable skills & knowledge acquired to transform the society.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

VISION

"To achieve excellence in academics and research in Electronics & Communication Engineering to meet societal need".

MISSION

- To impart quality technical education with the relevant technologies to produce industry ready engineers with ethical values.
- To enrich experiential learning through active involvement in professional clubs & societies.
- To promote industry-institute collaborations for research & development.

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

- Excel in professional career by acquiring domain knowledge.
- Motivation to pursue higher Education & research by adopting technological innovations by continuous learning through professional bodies and clubs.
- To inculcate effective communication skills, team work, ethics and leadership qualities.

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO1: Graduate should be able to understand the fundamentals in the field of Electronics & Communication and apply the same to various areas like Signal processing, embedded systems, Communication & Semiconductor technology.

PSO2: Graduate will demonstrate the ability to design, develop solutions for Problems in Electronics & Communication Engineering using hardware and software tools with social concerns.

PROGRAM OUTCOMES [PO's]

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem Analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern Tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

K. S INSTITUTE OF TECHNOLOGY, BENGALURU-560109

TENTATIVE CALENDAR OF EVENTS: II SEMESTER (2020-2021)

SESSION: MAY 2021 - SEP 2021

Week No.	Month	Day						Days	Activities
		Mon	Tue	Wed	Thu	Fri	Sat		
1	MAY			19*	20	21	22	4	19*-Commencement of II Semester 22 Monday Time Table
2	MAY	24	25	26	27	28	29DH	5	
3	MAY/JUNE	31	1	2	3	4	5	6	5 Wednesday Time Table
4	JUNE	7	8	9	10	11	12DH	5	
5	JUNE	14	15	16	17	18	19TA	6	19 Monday Time Table
6	JUNE	21T1	22T2	23T1	24	25	26DH	5	
7	JUNE/JULY	28	29	30	1	2	3	6	3 Thursday Time Table
8	JULY	5ASD	6	7	8	9	10DH	5	
9	JULY	12	13	14	15	16	17	6	17 Tuesday Time Table
10	JULY	19	20	21H	22	23TA	24DH	4	21 Bakrid / Eid al Adha
11	JULY/AUG	26T2	27T2	28T2	29	30	31	6	31 Monday Time Table
12	AUG	2	3	4	5	6 ASD	7	6	7 Wednesday Tme Table
13	AUG	9	10	11	12	13	14DH	5	
14	AUG	16	17	18	19	20H	21DH	4	20 Muharram
15	AUG	23	24	25	26T3	27T3	28T3	6	
16	AUG/SEP	30LT	31LT	1LT	2LT	3	4* ASD	6	4 Tuesday Time Table 4* Last working day

Total No of Working Days : 85

Total Number of working days (Excluding holidays and Tests)=72

H	Holiday
T1,T2, T3	Tests 1,2, 3
ASD	Attendance & Sessional Display
DH	Declared Holiday
LT	Lab Test
TA	Test attendance

Monday	15
Tuesday	14
Wednesday	14
Thursday	15
Friday	14
Total	**72**

PRINCIPAL
K.S. INSTITUTE OF TECHNOLOGY
BENGALURU - 560 109.

K. S INSTITUTE OF TECHNOLOGY, BENGALURU-560109
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING
TENTATIVE CALENDAR OF EVENTS: EVEN SEMESTER (2020-2021)
SESSION: APR 2021 - AUG2021

Week No.	Month	Day						Days	Activities	Department Activities Tentative Dates
		Mon	Tue	Wed	Thu	Fri	Sat			
1	APR	19 *	20	21	22	23	24	6	19* Commencement of Higher Semester 24 Wednesday Time Table	
2	APR/MAY	26	27	28	29	30	[illegible]	5	1 May Day	
3	MAY	[illegible]	4	5	6	7	[illegible]	6	8 Monday Time Table	3rd - 8th May AICTE - ISTE Induction / Refresher programme (FDP)
4	MAY	10	11	12	[illegible]	[illegible]	[illegible]	3	13 Idul Fitr 14 Basava Jayanti	
5	MAY	17	18	19	20	21	22TA	6	22 Tuesday Time Table	
6	MAY	[illegible]	[illegible]	[illegible]	27	28	[illegible]	5		24th - 29th May AICTE - ISTE Induction / Refresher programme (FDP)
7	MAY/JUN	31	1	2	3	4	5ASD	6	5 Wednesday Time Table	5th June IEEE KSIT SB Digital Siganal Processing Applications using MATLAB
8	JUN	7	8	9	10	[illegible]	12DH	5		11th June IETE Webinar, 11th June IEEE Power of Positive Thoughts Webinar
9	JUN	[illegible]	[illegible]	16	17	18	19	6	19 Monday Time Table	14th June Internet Communication and Networking Webinar 15th June IEEE KSIT SB CREAT WIE T1 Inter college Art Competation
10	JUN	21	22	23	24	25TA	[illegible]	5		
11	JUN/JUL	[illegible]	[illegible]	[illegible]	1	[illegible]	3	6	3 Thursday time Table	2nd July IETE Webinar
12	JUL	5	6	7	8	9ASD	[illegible]	5		
13	JUL	12	13	[illegible]	15	16	17	6	17 Tuesday Time Table	14th July ASH in association with IEEE-WIE Webinar
14	JUL	[illegible]	[illegible]	[illegible]	22	23	[illegible]	4	20 *VIII Sem Last working day 21 Bakrid / Eid al Adha	19th July IEEE KSIT SB FOUS FLOW Webinar
15	JUL	26	27	28TA	[illegible]	[illegible]	[illegible]	6		29,30,31 Practice Lab
16	AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7*T3	6	7 Wednesday Time Table	2,3,4 Practice Lab
17	AUG	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	14* IV &VI Last working day	10,11,12,13,14, 1st &2nd Lab Internals

Total No of Working Days : 92

Total Number of working days (Excluding holidays and Tests)=79

H	Holiday
T1,T2,T3	Tests 1,2, 3
ASD	Attendance & Sessional
DH	Declared Holiday
LT	Lab Test
TA	Test attendance

Monday	16
Tuesday	16
Wednesday	16
Thursday	16
Friday	15
Total	79

14

K.S.INSTITUTE OF TECHNOLOGY
LIST OF STUDENTS STUDYING IN I SEMESTER
FOR THE ACADEMIC YEAR 2020-2021
ELECTRONICS & COMMUNICATION ENGINEERING
CHEMISTRY CYCLE - SECTION D

SL NO	NAME OF THE STUDENT	STUDENT MOBILE NUMBER	STUDENT EMAIL ID	GENDER	DATE OF BIRTH	STUDENT AADHAR NUMBER	ADMISSION QUOTA	FATHER MOBILE NUMBER	MOTHER MOBILE NUMBER
1	ABHISHEK .J	9148909784	Abhiacchu03@gmail.com	Male	2002-01-03	834490962130	MANAGEMENT	9108332157	6362850169
2	ADITI DUBEY	9483670316	aditidubey2002@gmail.com	Female	2002-03-16	991583223129	MANAGEMENT	9901768702	9916143281
3	AFEEFA SHARIEFF	8722100935	afeefa.mms@gmail.com	Female	2002-10-20	711814434889	CET		7848078518
4	AJAY B.G	9663870637	ajaybg2002@gmail.com	Male	2002-02-26	6260 3599 0045	CET	9535128057	9663870637
5	AJAY GIRISH	+918660588332	ajaygirish72@gmail.com	Male	2002-06-06	265544669688	CET	9972038553	9980761620
6	AKASH .M	9113643268	akashlorotto@gmail.com	Male	2001-08-03	284090655844	MANAGEMENT	9538482446	9980491699
7	ANKITH.L								
8	ASHRIT MADHAV VADIRAJ	+918548813044	madhav281102@gmail.com	Male	2002-11-26	7588 1693 0131	CET	9167955657	9930813044
9	B.S.HEMASHREE	8553847390	hemashreekadam@gmail.com	Female	2002-03-24	486555026340	MANAGEMENT	8782285058	9449204361
10	BHARATH M	6366325889	bharath3202@gmail.com	Male	2002-02-09	2068 8721 1795	CET	7090600434	7619212525
11	BHAVITHA. B	7676182692	bhavithapriya02@gmail.com	Female	2002-08-19	404835165240	CET	8762182437	8762182437
12	BHUVANESHWARI.K	9731745184	bhuvik108@gmail.com	Female	2002-04-23	289534272314	CET	9845978879	7022606417
13	CHAITANYA. K	7204977937	Reddychaitanya401@gmail.com	Male	2002-03-16	531684146161	MANAGEMENT	9343776218	6362534847
14	CHAITHRA K	9964411457	jayalakshmisomayaji1971@gmail.com	Female	2002-04-06	731728312281	SNQ	9964411457	9686610271
15	CHALLAGUNDLA SAI SRUJITHA	7815834446	saisrujitha18@gmail.com	Female	2002-01-18	826492538470	COMEDK	9000558141	9390481542
16	CHALLAGUNDLA UMADEVI	6302775314	challagundlaumadevi14@gmail.com	Female	2002-11-20	847690641654	MANAGEMENT	9505737070	6303475858
17	CHAYA.S	8147025259	chayas2002@gmail.com	Female	2002-03-23	6534 4122 3905	MANAGEMENT	9448561585	9845198388
18	CHETHAN.C								
19	CHETHAN KUMAR J	9916319428	Chethankumarchethan20@gmail.com	Male	2002-07-20	577525137476	CET	9591087284	7349610103
20	CHETHAN KUMAR T	8971023827	chethankumar2420@gmail.com	Male	2002-09-24	696056864872	MANAGEMENT		7019722049
21	CHETHAN. G	6310415628	gchethan866@email.com	Male	2003-04-30	242387540674	CET	9066605369	8971800934
22	DARSHAN KUMAR	9902618252	darshu061202@gmail.com	Male	2002-12-06	334415471891	MANAGEMENT	8861840262	8861840262
23	DARSHAN.K	9148379478	darshan2243k@gmail.com	Male	2003-04-22	555053979701	CET	6363852337	9535250529
24	DEEPAK S	9380862154	deepakadithya1127@gmail.com	Male	2002-08-27	228590410766	MANAGEMENT	9741857589	9035259827
25	DHAMINI. J	9513680207	dhaminij0289@gmail.com	Female	2002-07-02	858427564110	CET	7829033976	7760916277
26	DHRUVA KUMAR. S	8073976871	dhruvakumar26190@email.com	Male	2002-02-15	488972805041	MANAGEMENT	9448212059	9886280175
27	DIVYA N	6310365659	divyanmurthy09@gmail.com	Female	2002-05-09	2584 0792 7811	MANAGEMENT	9945977171	9972629197
28	ESHWAR BIRADAR	7588247068	eshwarbb2003@gmail.com	Male	2003-01-03	6394 2491 9032	CET	7588247068	9108697635
29	G BHAVANA PRIYADARSHINI	8296196955	bhavanagorthi@gmail.com	Female	2002-10-14	441790519959	CET	9449977675	8973709003

30	GAGAN,H.C	6364769333	gagan888.hc@gmail.com	Male	2002-06-01	267277963799	MANAGEMENT	9845440151	9880883234
31	GAGANA B S	6360024748	gagana8904604388@gmail.com	Female	2002-09-18	3821 8246 7298	MANAGEMENT		
32	GANDHAMANI C M	9741398268	cmgandhamani@gmail.com	Female	2002-04-07	6292 4686 3760	MANAGEMENT	9448233588	8892243982
33	GOMITHA R C	9618248007	rcgomitha@gmail.com	Female	2002-06-02	2428 0738 5462	CET	9620403338	7892682284
34	HARINI K	9900704653	kharini810@gmail.com	Female	2002-03-24	785401815780	MANAGEMENT	7259506961	6364485871
35	HARSHITH GOWDA AR	8123268819	harshithgowdas04@gmail.com	Male	2002-09-04	725548783778	CET	9008273087	8197111248
36	HARSHITHA .B.L	7892192846	harshithabl15@gmail.com	Female	2002-08-15	5376 7342 8223	MANAGEMENT	9845757201	9740154601
37	HARSHITHA J	9113684507	jjayaram223@gmail.com	Female	2002-09-23	544252455949	MANAGEMENT	9980381765	9113684507
38	HARSHITHA N	8884395824	harshithan392@gmail.com	Female	2002-12-22	970382753294	MANAGEMENT	8884951994	9448617364
39	INCHARA. P	6361694403	TejuPc182@gmail.com	Female	2002-01-24	624993685627	MANAGEMENT	8105544866	8361694403
40	JAMPULA CHAITHANYA KRISHNA	7780685993	chaithanyajampula1@gmail.com	Male	2003-04-30	882064083124	MANAGEMENT	9059040509	9705377583
41	JAMUNA S.G	9353868269	Jamuna123@gmail.com	Female	2002-02-16	946865933228	SNQ	8123389095	7259354079
42	JANHAVI R	8073864130	Janvirajanviraj042@gmail.com	Female	2003-02-13	850121372273	CET	8073057764	6366086700
43	JAYANTH.H	9632619629	jayanth.h6174@gmail.com	Male	2002-02-09	712845687141	CET	9880767316	9141073887
44	S. ARUN KUMAR	9480515998	rahularunkumar5@gmail.com	Male	2003-01-13	235640391692	CET	9060001979	9480515998
45	SACHIN N M	8431949810	sachinnmgol@gmail.com	Male	2002-07-13	2817 8086 3599	CET	9972077572	
46	SADHANA.SRINIVAS	6361916229	sadhana.srinivas6@gmail.com	Female	2002-08-05	4794 0804 3088	MANAGEMENT	9108587382	9108287469
47	SAKSHAM SINGH	7892803406	singh.saksham221201@gmail.com	Male	2001-12-22	313839322823	MANAGEMENT	8217879314	9741628210
48	SANDEEP Y H	9741435215	sandeepyhsandeepyh@gmail.com	Male	2002-07-01	530408584559	CET	9901889154	9880711052
49	SANGEETHA G S	8496954392	Sangeethareddys90@gmail.com	Female	2002-10-04	527463128627	CET	8722322382	8088038955
50	SANJANA G.	7676947607	sanjanatantry03@gmail.com	Female	2002-07-14	7174 7766 4635	MANAGEMENT	9448242991	9844456741
51	SANJANA T GADIKAR	7411745842	sanjanatgadikar@gmail.com	Female	2002-06-14	5935 7765 1098	MANAGEMENT	9900137102	7411724316
52	SANJANA.G	9743932931	Sanjana.gurunaths@gamil.com	Female	2002-08-28	397481751848	MANAGEMENT	9686474373	8277201905
53	SHAKTHI ANBAZHAGAN M	6363195088	anbumuniyappa@gmail.com	Male	2002-08-25	4963 6596 9096	CET	9980122908	9844201698
54	SHARATH M	8050032264	Sharathm5684@gmail.com	Male	2002-09-18	912381707743	CET	9480075858	8277784542
55	SHASHANK.S	08867116224	Shashanksiddaraj2002@gmail.com	Male	2002-05-04	203779413522	CET	9535220018	7975633792
56	SHIVAREDDY.B A	9686526103	shivareddyba56@gmail.com	Male	2001-01-10	814334274002	CET	9731055616	9902595576
57	SHREYA H PADMANABHA	7676869258	shreyah532@gmail.com	Female	2002-06-01	380931056507	MANAGEMENT	9902308548	9743042590
58	SHREYAS M S	8050289057	shrema08@gmail.com	Male	2002-08-21	3522 9176 1549	MANAGEMENT	9845447704	9900379104
59	SHEYAS P S RAO	6364557803	sshreyas578@gmail.com	Male	2002-09-27	881405628965	MANAGEMENT	9343835454	9341229890
60	SHWETA DEEPAK K	8050289057	shrems08@gmail.com	Male	2002-08-21	3522 9176 1549	MANAGEMENT	9845447704	9900379104
61	RAMESHWAR	7411390961	makrerameshwar6@gmail.com	Female	2001-07-22	5372 6183 8603	CET	9972331377	

K.S.INSTITUTE OF TECHNOLOGY
LIST OF STUDENTS STUDYING IN I SEMESTER
FOR THE ACADEMIC YEAR 2020-2021
ELECTRONICS & COMMUNICATION ENGINEERING
CHEMISTRY CYCLE - SECTION E

SL NO	NAME OF THE STUDENT	STUDENT MOBILE NUMBER	STUDENT EMAIL ID	GENDER	DATE OF BIRTH	STUDENT AADHAR NUMBER	ADMISSION QUOTA	FATHER MOBILE NUMBER	MOTHER MOBILE NUMBER
1	K. JEEVITHA	7899632686	jeevitha020821@gamil.com	Female	2002-08-21	580991565541	MANAGEMENT	9845723669	7795122978
2	K.M.AMSHUMANTH	9742095512	amshu.cr7@gmail.com	Male	2002-04-24	792232249433	CET	9880280939	9900658170
3	K.R.SAHANA	95138 53609	shettysahana170@gmail.com	Female	2003-03-28	920036200271	CET	9869702032	8369915038
4	KAVANA G.S.	9148137238	kavanags0613@gmail.com	Female	2002-06-13	330896170763	MANAGEMENT	7829221728	9611438411
5	KAVYA S.M.	7795924125	kavyasm12345@gmail.com	Female	2002-02-20	661019787791	SNQ	9019615633	9844856115
6	KEERTHANA B.S.	8431466578	Keerthanabspvg2003@gmail.com	Female	2003-01-16	726361082457	MANAGEMENT	9972262282	9972262282
7	KIRAN DEV.D.	7411158049	devkiran8049@gmail	Male	2002-11-24	526054766706	CET	9845548049	9341448049
8	KIRAN V NARAYAN	6366955248	kirannarayan0@gmail.com	Male	2002-07-09	822970476903	OTHERS	9945944229	9945337238
9	KODIDELA PRATHIMA	9392399402	kodidelaprathima2002@gmail.com	Female	2002-01-05	365484117677	MANAGEMENT	7989193663	8897279698
10	KUMAR K.G.	9071942191	ganeshkumar9035@gmail.com	Male	2002-09-02	581803647874	SNQ	9035415059	9591160548
11	KUSUMA.V.R	8792098538	Kusumavr2710@gmail.com	Female	2002-10-27	9453 3212 9798	CET	9945357476	8861356613
12	MADIHA	9845357377	mazharmadiha786@gmail.com	Female	2002-04-23	3473 0956 9875	CET	9980778851	9660026800
13	MAHESH BIRADAR	8088718524	maheshbiradar6762@gmail.com	Male	2002-10-05	482187325217	CET	9606619067	8762779748
14	MANASWINI K.M.	9148591462	manaswigowda0@gmail.com	Female	2002-07-15	935269760360	MANAGEMENT		9008739026
15	MEGHA SHREE.M	9206532206	roopamegha2002@gmail.com	Female	2002-04-23	889046743152	CET	9206532206	9742171972
16	MOHAN KRISHNA .K	9380891045	mohankrishnak931@gmail.com	Male	2001-03-09	345296171110	SNQ	9686225657	6361450765
17	N. SHREYA	8147128278	Shreyasrivatsa25@gmail.com	Female	2002-11-25	690763605927	CET	9980028278	9900411278
18	NALLANI GOWTHAMI	7032681854	nallanigowthami2002@gmail.com	Female	2002-06-08	833458475298	MANAGEMENT	9959669329	6303344071
19	NAVYASHREE.R.	9392215196	Navyashree9482@gmail.com	Female	2002-06-06	874382207922	MANAGEMENT		9482441132
20	NEHA C.R	9108573852	ramegowdam1971@gmail.com	Female	2003-01-01	751974950565	CET	8892596410	9108573852
21	NEHA NAGRAJ AIRANI	9886248430	airanineha5@gmail.com	Female	2002-05-11	344917160694	MANAGEMENT	09535685226	9449184581
22	P.VASANTH KUMAR REDDY	7483506301	vasanthkumar44881@gmail.com	Male	2002-04-16	283653135763	MANAGEMENT		7483506301
23	PAVAN .C.	8317411141	pavanreddy6896@gmail.com	Male	2002-07-15	539427616012	MANAGEMENT	9632778063	8317411141
24	PAVANI T.S.	7619183036	talluripavani76@gmail.com	Female	2003-03-20	4517 2448 3540	CET	9972693036	9591713501
25	PRADHYUMNA S. KASHYAP	9740736084	pradhyumnakashyap7942@gmail.com	Male	2002-02-27	725703929167	SNQ	9980412184	8861476084
26	PRAVEEN D.B	8618964201	bpraveen.1707@gmail.com	Male	2002-07-17	813595278034	CET		8618964201
27	PREMA .G	8951273603	Gopalsusheelareddy@gmail.com	Female	2003-05-13	417538492615	CET	9611329572	8971472513
28	PRIYANKA .M.								
29	PRIYANKA. K.	6362989867	kpriyanka93033@gmail.com	Female	2002-02-01	3077 8724 7646	CET	9535047009	7483494379
30	PRIYANKA.H C	9663826792	Sumanth.777hc@gmail.com	Female	2002-07-15	816474981108	CET	9902296912	9663826792

31	PUSHPA D.T	7483778566	pushp[illegible]96@gmail.com	Female	2002-04-01	889563207342	MANAGEMENT	9535135687	9964160640
32	RAHUL KRISHNAN .V.	9480123426	rkv122[illegible]01@gmail.com	Male	2001-04-12	74223[illegible]43861	SNQ	9449444403	9449444520
33	RAHUL R.	8431011477	RahulRhmu@gmail.com	Male	2001-09-08	759020370212	MANAGEMENT		8535510733
34	RAJATH K ACHAR	9380682309	rajathkachar143@gmail.com	Male	2002-08-14	841360533105	MANAGEMENT		
35	RAKSHITH. N.M.	9632115351	No	Male	2002-01-17	2045 7009 7250	MANAGEMENT		
36	RAKSHITH.R	7892065979	rakshith197@gmail.com	Male	2002-01-05	3677 2852 8616	CET	9980601937	7892065979
37	RAKSHITHA .A	8147257648	rakshithaanthony1@gmail.com	Female	2002-12-31	839804945435	CET	9880036569	8073485262
38	RAMYA .T	6363683042	ramyatramya03@gmail.com	Female	2002-12-01	855143847534	CET	9886672905	
39	RAVI VAMSHI D.N.	7349163962	Ravipothuparthi@gmail.com	Male	2001-08-15	216971176335	MANAGEMENT	8105521520	7975971165
40	ROHITH A.K.	9663921545	nishakanni5@gamil.com	Male	2002-09-24	6925 0127 9398	CET	9880418356	9663921545
41	SNEHA.A.S	9108408809	snehaaa1003@gmail.com	Female	2002-03-10	3419 9139 1468	CET	9379918669	9606875715
42	SONIKA R	9980733590	sonikajk1@gmail.com	Female	2002-12-11	8685 0875 5415	MANAGEMENT	9916897160	9986849682
43	SUHAS.G								
44	SUMANA N.	8884199651	sumanarayan20@gmail.com	Female	2002-06-20	8012 6520 8393	CET	9663342083	9738722600
45	SUMUKHA S	9380204638	sumukha4012003@gmail.com	Male	2003-01-04	769310549484	MANAGEMENT		9591248708
46	SURAKSHA.N	9108675849	suraksha.nagaraj@gmail.com	Female	2002-05-06	372490988938	CET	9845809413	9632459970
47	TARUN PRASANNA	8660233065	tarunp2405@gmail.com	Male	2002-05-24	280108498583	MANAGEMENT	8805236881	7722007910
48	TEJAS.N.REDDY	9606559319	reddytejas18@gmail.com	Male	2002-07-18	876566021194	CET	9880178585	6364743051
49	THUMMALA GIRISH CHOWDARY	6304887699	thummalagirishchowdary2003@gmail.com	Male	2003-08-13	352673515883	OTHERS	9502022945	
50	UDAY C.H.	8660434249	udaych810@gmail.com	Male	2002-04-16	433165975179	CET	9900138435	9513820968
51	UJJWAL NAIDU	9353513629	kandraujjwalnaidu16@gmail.com	Male	2001-05-13	871535762909	CET	9663574352	7259488464
52	VAISHNAVI .A.	7975440553	vaishnavibharadwaj1817@gmail.com	Female	2001-12-26	416556653816	CET	8217596332	9845508194
53	VAISHNAVI V.H.	8660383450	vaishnavivadagoor@gmail.com	Female	2002-09-01	975879002749	MANAGEMENT	9663878282	8660383450
54	VARSHA N	9740644194	varshanachar@gmail.com	Female	2002-04-16	5247 3583 7995	MANAGEMENT	9980465195	9449792744
55	VIJAYALAKSHMI.K	7349262315	vijayalakshmik025@gmail.com	Female	2002-04-05	734201686788	CET	9448169331	9481037802
56	VINAY S.P	8904305025	vinaysp6522@gmail.com	Male	2002-05-06	865405442850	CET	9972225344	6361875036
57	VINAY SAGAR.V.ALUR	81500 45445	sagarvinay1703@gmail.com	Male	2003-01-17	590719351827	CET	9980626767	9620350096
58	VINEETH.M.S	7975857991	msvineeth70@gmail.com	Male	2002-11-21	961165927080	CET	8861747925	8660120955
59	YASHILAA.S	7975689781	Yashilaa028@gmail.com	Female	2002-05-28	246976589175	MANAGEMENT	9845545398	9980741101
60	YASHWANTH Y	9535056009	Yashwanthshetty281@gmail.com	Male	2002-11-07	4473 4183 9154	CET	8361313577	7204758962

HOD

K.S.INSTITUTE OF TECHNOLOGY, BENGALURU-109
OFF-LINE CLASSES TIME -TABLE FOR II SEMESTER (2020 - 2021)
PHYSICS CYCLE

Branch:Electronics & Communication Engg SECTION : E

Class Teacher: Mr.CHOWDAPPA.M.R

Seminar Hall :Fourth Floor

OFF-LINE CLASSES W.e.f :16.08.2021

PERIOD	1	2	10.20 AM - 10.35 AM	3	4	12.25 PM- 1.15 PM	5	6	7
TIME/ DAY	8.30 AM - 9.25 AM	9.25 AM - 10.20 AM		10.35 AM - 11.30 AM	11.30 AM - 12.25 PM		1.15 PM - 2.10 PM	2.10 PM - 3.05 PM	3.05 PM - 4.00PM
MON	CIVIL 18CIV24	BEE 18ELE23	BREAK	MATHS 18MAT21	PHY 18PHY22	LUNCH BREAK	← 18EGDL25 LAB →		
TUE	BEE 18ELE23	CIVIL 18CIV24		MATHS 18MAT21	PHY 18PHY22		← 18PHYL26 E1 / 18ELEL27 E2 →		
WED	CIVIL 18CIV24	BEE 18ELE23		MATHS 18MAT21	PHY 18PHY22		18EGDL25	18EGDL25	LIB
THU	MATHS 18MAT21	PHY 18PHY22		CIVIL 18CIV24	BEE 18ELE23		EGH 18EGH28	18EGDL25	18EGDL25
FRI	PHY 18PHY22	CIVIL 18CIV24		MATHS 18MAT21	BEE 18ELE23		← 18PHYL26 E2 / 18ELEL27 E1 →		

SUBJECT CODE	SUBJECT NAME	FACULTY NAME
18MAT21	ADVANCED CALCULUS AND NUMERICAL METHODS	Mr.CHOWDAPPA.M.R
18PHY22	ENGINEERING PHYSICS	Dr.RENUKA.C
18ELE23	BASIC ELECTRICAL ENGINEERING	Mrs.VISHALINI DIWAKAR
18CIV24	ELEMENTS OF CIVIL ENGINEERING AND MECHANICS	Mrs.TEJASWINI.M.L
18EGDL25	ENGINEERING GRAPHICS	Mr.MANJUNATH.B.R
18PHYL26	ENGINEERING PHYSICS LABORATORY	Dr.RENUKA.C , Mr.SUNIL KUMAR.N
18ELEL27	BASIC ELECTRICAL ENGINEERING LABORATORY	Mrs.VISHALINI DIWAKAR,Mr. SATHISH KUMAR B
18EGH28	TECHNICAL ENGLISH-II	Mrs.ANURADHA.M.V

HOD

Head of the Department
Department of Science and Humanities
K.S. Institute Of Technology, [illegible]

PRINCIPAL

Principal
K.S. INSTITUTE OF TECHNOLOGY
BANGALORE - 560 062

K.S.INSTITUTE OF TECHNOLOGY, BENGALURU-109
OFF-LINE CLASSES TIME -TABLE FOR II SEMESTER (2020 - 2021)
PHYSICS CYCLE

Branch:Electronics & Communication Engg SECTION : D
Class Teacher:Mr.VENKATARAMANA.B.S
Seminar Hall :Third Floor

OFF-LINE CLASSES W.e.f :16.08.2021

PERIOD	1	2		3	4		5	6	7
TIME/ DAY	8.30 AM - 9.25 AM	9.25 AM - 10.20 AM	10.20 AM - 10.35 AM	10.35 AM - 11.30 AM	11.30 AM - 12.25 PM	12.25 PM- 1.15 PM	1.15 PM - 2.10 PM	2.10 PM - 3.05 PM	3.05 PM - 4.00PM
MON	PHY 18PHY22	MATHS 18MAT21	BREAK	CIVIL 18CIV24	BEE 18ELE23	LUNCH BREAK	← 18PHYL26 D1 / 18ELEL27 D2 →		
TUE	18EGDL25	18EGDL25		PHY 18PHY22	BEE 18ELE23		EGH 18EGH28	MATHS 18MAT21	CIVIL 18CIV24
WED	MATHS 18MAT21	PHY 18PHY22		CIVIL 18CIV24	BEE 18ELE23		← 18PHYL26 D2 / 18ELEL27 D1 →		
THU	BEE 18ELE23	PHY 18PHY22		18EGDL25	18EGDL25		MATHS 18MAT21	CIVIL 18CIV24	LIB
FRI	PHY 18PHY22	BEE 18ELE23		MATHS 18MAT21	CIVIL 18CIV24		← 18EGDL25 LAB →		

SUBJECT CODE	SUBJECT NAME	FACULTY NAME
18MAT21	ADVANCED CALCULUS AND NUMERICAL METHODS	Mr.VENKATARAMANA.B.S
18PHY22	ENGINEERING PHYSICS	Mr.SUNIL KUMAR.N
18ELE23	BASIC ELECTRICAL ENGINEERING	Mrs.VISHALINI DIWAKAR
18CIV24	ELEMENTS OF CIVIL ENGINEERING AND MECHANICS	Mrs.TEJASWINI.M.L
18EGDL25	ENGINEERING GRAPHICS	Mr.MANJUNATH B R
18PHYL26	ENGINEERING PHYSICS LABORATORY	Mr.SUNIL KUMAR.N , Dr.RENUKA.C
18ELEL27	BASIC ELECTRICAL ENGINEERING LABORATORY	Mrs.VISHALINI DIWAKAR, Mrs.PRIYADARSHINI J PATIL
18EGH28	TECHNICAL ENGLISH-II	Mrs.ANURADHA.M.V

16/8/21
HOD
Head of the Department
Department of Science and Humanities
K.S. Institute Of Technology, Bengaluru-109.

PRINCIPAL
Principal
K.S. INSTITUTE OF TECHNOLOGY
BANGALORE - 560 062

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE -109
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING
INDIVIDUAL TIME TABLE FOR THE YEAR - 2021 (EVEN SEMESTER)

W.E.F. : 19/4/2021

NAME OF THE FACULTY : VISHALINI DIVAKAR **DESIGNATION: ASSISTANT PROFESSOR**

PERIOD	1	2		3	4		5	6	7
TIME / DAY	8.30 AM 9.25 AM	9.25 AM 10.20 AM	10.20 AM 10.35 AM	10.35 AM 11.30 AM	11.30 AM 12.25 PM	12.25 PM 1.15 PM	1.15 PM 2.10 PM	2.10 PM 3.05 PM	3.05 PM 4.00 PM
MON		BEE 18ELE23 E	TEA BREAK		BEE 18ELE23-D	LUNCH BREAK	← BEE LAB D2 (18ELEL27) →		
TUE	BEE 18ELE23 E				BEE 18ELE23-D		← BEE LAB E2 (18ELEL27) →		
WED		BEE 18ELE23 E			BEE 18ELE23-D		← BEE LAB D1 (18ELEL27) →		
THU	BEE 18ELE23-D				BEE 18ELE23 E				
FRI		BEE 18ELE23-D			BEE 18ELE23 E		← BEE LAB E1 (18ELEL27) →		

	Subject Code	Subject Name	Sem	Section	Work Load
SUBJECT 1	18ELE23	Basic Electrical Engineering	II	D E	10
Lab -2	18ELEL27	Basic Electrical Engineeing Laboratory,	IV	DE	4.5
Internship	17EC84	Internship/Professional Practice	VIII		2
Project	17ECP85	Project Work	VIII		2
ADDITIONAL WORK: MENTORING AND OTHERS					
TOTAL LOAD= 18.5 Hrs/Week					

Time Table Co-ordinator

HOD 18/4

HEAD OF THE DEPARTMENT
Dept. of Electronics & Communication Engg
K.S. Institute of Technology
Bangaluru - 560 109

Principal

PRINCIPAL
K.S. INSTITUTE OF TECHNOLOGY
BENGALURU - 560 109.

K. S. INSTITUTE OF TECHNOLOGY

#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru-5600109

DEPARTMENT OF ELECTRONICS &COMMUNICATION ENGINEERING

CO-PO mapping: Basic Electrical Engineering

Course : **Basic Electrical Engineering** – 2021 EVEN/ECE

Course In-charge : Vishalini Divakar

Type: Core	**Course Code:18ELE13/23**

No of Hours per week

Theory (Lecture Class)	Practical/Field Work/Allied Activities	Total/Week	Total teaching hours
5	0	5	60

Marks

Internal Assessment	Examination	Total	Credits
40	60	100	3

Aim/Objective of the Course:

This course enables students to:

- To explain Ohm's Law and Kirchhoff's Laws used for analysis of DC circuits.
- To explain fundamentals of AC circuits and the behaviour of R, L and C and their combination in AC circuits.
- To discuss three phase balanced circuits.
- To explain principle of operation, construction & performance of electrical machines such as single phase transformers, DC Machines, Synchronous generator and three Phase Induction Motor.
- To introduce concepts of electrical wiring, circuit protecting devices and Earthing.

Course Learning Outcomes:

After completing the course, the students will be able to, Bloom's Level

CO1	**Make use of** Ohm's law & Kirchhoff's laws to study the behaviour of electrical circuits with DC sources.	K3 APPLYING
CO2	**Establish** relationship between different quantities of electrical circuits powered by Single phase and three phase AC sources.	K3 APPLYING
CO3	**Identify** the operation of single phase transformers and the concepts of electrical wiring.	K3 APPLYING
CO4	**Identify** the performance characteristics of three phase AC Generators and motors.	K3 APPLYING
CO5	**Estimate** the performance of DC generators and DC motors.	K3 -APPLYING

Syllabus Content:	
Module 1: **D.C.Circuits:** Ohm's Law and Kirchhoff's Laws, analysis of series, parallel and series-parallel circuits excited by independent voltage sources. Power and Energy. **A.C. Fundamentals:** Generation of sinusoidal voltage, frequency of generated voltage, definition and numerical values of average value, root mean square value, form factor and peak factor of sinusoidally varying voltage and current, phasor representation of alternating quantities. LO: At the end of this session the student will be able to, 1. Explain Ohm's Law. 2. Explain Kirchhoff's. Laws. 3. Analyse DC circuits 4. Understand the Fundamentals of AC circuits	**CO1** **12 Hrs** PO1-3 PO2-2
Module 2: **Single Phase Circuits:** Analysis with phasor diagram, of circuits with R,L,C, R-L, RC, R-L-C for series and parallel configurations. Real power, reactive power, apparent power and power factor. **Three Phase circuits:** Advantages of 3-phase power, Generation of 3-phase power, Three-phase balanced circuits, voltage and current relations in star and delta connections. Measurement of three phase power using two wattmeter method. LO: At the end of this session the student will be able to, 1. Explain the behaviour of R, L and C and their combination in AC circuits. 2. Understand the significance of power and power factor in AC circuits. Explain the operation of Three phase AC circuits.	**CO212** **Hrs** PO1-3 PO2-2
Module 3: Single Phase Transformers: Necessity of transformer, Principle of operation, Types and construction of transformers. emf equation, losses, variation of losses with respect to load, efficiency, Condition for maximum efficiency. **Domestic Wiring:** Service mains, meter board and distribution board. Brief discussion on concealed conduit wiring. Two-way and three-way control. Elementarydiscussiononcircuitprotectivedevices:FuseandMiniatureCircuit Breaker(MCB's), electric shock, precautions against shock. Earthing: Pipe and Plate earthing. LO: At the end of this session the student will be able to, 1. Explain the principle of operation and construction of single phase Transformers. 2. Understand the Concepts of electrical wiring 3. Understand the working of protective devices	**CO3** **12 Hrs** PO1-3 PO2-2 PO7-2 PO6-2
Module 4: DC Generators: Principle of operation, Construction of D.C. Generators. Expression for induced emf, Types of D.C. Generators, Relation between induced emf and terminal voltage. **DC motors**: Principle of operation, Back emf, Torque equation, Types of dc motors, Characteristics of dc motors (shunt and series motors only) and Applications. LO: At the end of this session the student will be able to, 1. Explain the principle of operation and construction of DC Machines. 2. Understand the classification of the DC machines. 3. Understand the application of DC motors.	**CO5** **12 Hrs** PO1-3 PO2-3 PO6-1

CO - PO MAPPING

PO1: Science and engineering Knowledge **PO2:** Problem Analysis **PO3:** Design & Development **PO4:**Investigations of Complex Problems **PO5:** Modern Tool Usage **PO6:** Engineer & Society	**PO7:**Environment and Society **PO8:**Ethics **PO9:**Individual & Team Work **PO10:** Communication **PO11:**Project Management & Finance **PO12:**Lifelong Learning

PSO1: Graduate should be able to understand the fundamentals in the field of Electronics Communication and apply the same to various areas like Signal processing, embedded system Communication & Semiconductor technology.

PSO2: Graduate will demonstrate the ability to design, develop solutions for Problems in Electronics& Communication Engineering using hardware and software tools with social concerns.

CO 18ELE13/ 23	Bloom's Level	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO1	PSO2
CO1	K3	3	2	–	–	–	–	–	–	–	–	–	–	2	1
CO2	K3	3	2	–	–	–	–	–	–	–	–	–	–	2	1
CO3	K3	3	2	–	–	–	2	2	–	–	–	–	–	2	1
CO4	K3	3	2	–	–	–	1	–	–	–	–	–	–	2	1
CO5	K3	3	2	–	–	–	1	–	–	–	–	–	–	2	1
18ELE13		3	2	–	–	–	1.33	3	–	–	–	–	–	2	1

Module 5:Three Phase Synchronous Generators: Principle of operation, Constructional details, Synchronous speed, Frequency of generated voltage, emf equation, Concept of winding factor (excluding the derivation and calculation of distribution and pitch factors). **Three Phase Induction Motors:** Principle of operation, Generation of rotating magneticfield,Constructionandworkingofthree-phaseinductionmotor,Slip and its significance. Necessity of starter, star-delta starter. LO: At the end of this session the student will be able to, 1. Understand the constructional details and working principle of Three Phase Induction Motor. 2. Understand the constructional details and working principle of Three Phase Synchronous generators. Understand the need of starters for three phase Induction motor.	**CO4** **12 Hrs** PO1-3 PO2-1 PO6-1 PO12

Text Books: - (specify minimum two foreign authors text books)

1. Basic Electrical Engineering, D C Kulshreshtha, Tata McGraw Hill, Revised First Edition.
2. Principles of Electrical Engineering & Electronics, V.K. Mehta, Rohit Mehta, S.ChandPublications.

Reference Books:

1. Fundamentals of Electrical Engineering and Electronics, B. L. Theraja, S. Chand & Company Ltd, Reprint Edition 2013.
2. Electrical Technology, E. Hughes, International Students 9th Edition, Pearson, 2005

Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, 2017

Useful Journals:

- Electrical Engineering
- IEEE Transactions on Power Apparatus and Systems
- Journal of the Institution of Electrical Engineers
- Wiring Installations and Supplies

Teaching and Learning Methods:

1. Lecture class: 60 hrs.
2. Self-study: 10hrs.
3. Field visits/Group Discussions/Seminars: -

Practical classes: 3hrs.

Assessment:

Type of test/examination: Written examination

Continuous Internal Evaluation(CIE) : 40 marks (Average of best two of total three tests will be considered)

Semester End Exam(SEE) : 60 marks (students have to answer all main questions)

Test duration: 1 :30 hr

Examination duration: 3 hrs

Justification for CO-PO and CO-PSO mapping

CO	PO	Justification for PO mapping
CO1	PO1-3 (High)	The knowledge of basic concepts of mathematics ,Science and engineering fundamentals will help students to apply basic laws to study the behaviour of electrical circuits with DC sources
	PO2-2 (Moderate)	Students will Identify and review the research literature while selecting the mini-project.
	PSO1-2 (Moderate)	The knowledge of Ohm's Law and Kirchoff's laws will help to understand the fundamentals in the field of Electronics & Communication.
	PSO2-1 (Low)	The knowledge of Ohm's Law and Kirchoff's laws will help to develop solutions for Problems in Electronics& Communication Engineering using hardware and software tools.
CO2	PO1-3 (High)	The knowledge of basic concepts of mathematics, Science and engineering fundamentals will help students to identify the behaviour of electrical circuits with Single phase and three phase AC sources.
	PO2-2 (Moderate)	Students will Identify and review the research literature while selecting the mini-project.
	PSO1-2 (Moderate)	The knowledge of Single phase and 3 phase AC circuits will help to understand the fundamentals in the field of Electronics & Communication.
	PSO2-1 (Low)	The knowledge of Single phase and 3 phase AC circuits will help to develop solutions for Problems in Electronics Engineering using hardware and software tools.
CO3	PO1-3 (High)	The knowledge of basic concepts of mathematics, Science and engineering fundamentals will help students Identify the operation of single phase transformers and the concepts of electrical wiring.
	PO2-2 (High)	Concepts of single phase transformers, domestic wiring, protecting devices and earthing will help to develop problem analysing ability in practical applications of electrical system.
	PO6-2 (Moderate)	Study of protecting devices and earthing for safety issues will help in applying the contextual knowledge in the professional engineering practice.
	PO7-2 (Moderate)	Students continues to understand about essentiality of protective devices, precautionary measures to avoid electrics shock to safeguard the surrounding environment from electrical abnormalities that takes place in power system.
	PSO1-2 (Moderate)	The knowledge of transformers and domestic wiring is useful to understand the fundamentals in the field of Electronics & Communication.
	PSO2-1 (Low)	The knowledge of transformers and domestic wiring is useful to develop solutions for Problems in Electronics & Communication Engineering using hardware and software tools.
CO4	PO1-3 (High)	The knowledge of basic concepts of mathematics, Science and engineering fundamentals will help students Analyse the performance characteristics of three phase AC Generators

		and motors.
	PO2-2 (Moderate)	Concepts of AC generators and AC motors will help to develop problem analysing ability in practical applications of electrical system.
	PO6-1 (Low)	Study of working of AC generators and AC motors will help in applying the contextual knowledge in the professional engineering practice.
	PSO1-2 (Moderate)	The study of the performance of AC generators and Motors can be used for the application of the fundamentals in the field of Electronics & Communication.
	PSO2-1 (Low)	The knowledge about the working of AC generators and AC motors is useful to develop solutions for Problems in Electronics Engineering using hardware and software tools.
CO5	PO1-3 (High)	The knowledge of basic concepts of mathematics, Science and engineering fundamentals will help students analyse operation of DC generators and DC motors.
	PO2-2 (Moderate)	Study of DC generators and DC motors will help to develop problem analysing ability in practical applications of electrical system.
	PO6-1 (Low)	Study of working of DC generators and DC motors will help in applying the contextual knowledge in the professional engineering practice.
	PSO1-2 (Moderate)	The study of the performance of DC generators and Motors can be used for the application of the fundamentals in the field of Electronics & Communication.
	PSO2-1 (Low)	The knowledge about the working of DC generators and DC motors is useful to develop solutions for Problems in Electronics Engineering using hardware and software tools.

Course In-Charge

Module Co-ordinator

HOD

K S INSTITUTE OF TECHNOLOGY BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGG.

NAME OF THE STAFF : VISHALINI DIVAKAR
SUBJECT CODE/NAME : 18ELE23/BASIC ELECTRICAL ENGINEERING
SEMESTER/YEAR : II/ I
SECTION : D,E
ACADEMIC YEAR : 2020-2021

Sl. No .	Topics to be covered	Mode of Delivery	Teaching Aid	No. of Periods	Cumulative No. of Periods	Proposed Date
	MODULE 1: DC Circuits & AC fundamentals					
1	**D C circuits**: Ohm's Law, Power and Energy.	L+D	BB	1	1	19-5-21
2	Analysis of series, parallel and series parallel circuits excited by independent voltage sources.	L+ D	BB	1	2	20-5-21
3	Kirchhoff's Laws-KVL, KCL	L+ D	BB	1	3	21-5-21
4	Illustrative examples on combinational circuits.	L+PS	BB	1	4	22-5-21
5	Illustrative examples on current division and voltage division rule.	L+PS	BB	1	5	24-5-21
6	Illustrative examples on Kirchhoff's laws.	L+D	BB	2	7	25-5-21 26-5-21
7	**Single-phase AC Fundamentals:** Generation of sinusoidal voltage, frequency of generated voltage.	L+AV	LCD	1	8	27-5-21
8	Definition and numerical values of average value, root mean square value.	L+D	BB	1	9	28-5-21
9	Form factor and peak factor of sinusoidally varying quantities, phasor representation of alternating quantities	L+D	BB	1	10	31-5-21
10	Illustrative examples	L+D	BB	2	12	1-6-21 2-6-21
11	**Class Test 1**					3-6-21
	MODULE 2:Single phase Circuits & Three phase Circuits					
12	**Single Phase AC Circuits:** Analysis, with phasor diagrams, of R, L circuit.	L+D	BB	1	13	4-6-21
13	Analysis, with phasor diagrams, of C AND R-L circuit.	L+D	BB	1	14	5-6-21
14	Analysis, with phasor diagrams, of R-C and R-L-C circuits	L+D	BB	1	15	7-6-21

15	Parallel and series- parallel circuits. Real power, reactive power, apparent power and power factor.	L+D	BB	1	16	8-6-21
16	Real ,reactive, apparent power and power factor	L+D	BB	1	17	9-6-21
17	Illustrative examples on series R-L, R-C circuit.	L+D	BB	1	18	10-6-21
18	Illustrative examples on series R-L, R-C circuit.	L+PS	BB	1	19	11-6-21
19	Illustrative examples series R-L-C circuit	L+PS	BB	1	20	15-6-21
20	Illustrative examples parallel R-L-C circuit	L+PS	BB	1	21	17-6-21
21	**Three Phase Circuits:** Advantages of three phase power, generation of three phase power.	L+AV	LCD	1	22	19-6-21
22	Three phase balanced circuit, Relationship between voltage and current in star connections.	L+D	BB	1	23	21-6-21
23	Relationship between voltage and current delta connections.	L+D	BB	1	24	22-6-21
24	Measurement of three phase power by two-wattmeter method.	L+D	BB	1	25	23-6-21
25	Determination power factor using wattmeter readings.	L+D	BB	1	26	25-6-21
	Internal Assessment I			1	27	29-6-21
26	Illustrative examples on finding current and voltage.	L+D	BB	1	28	1-7-21
27	Illustrative examples on finding phase parameters.	L+PS	BB	2	30	2-7-21 3-7-21
28	Illustrative examples on Wattmeter Readings.	L+PS	BB	1	31	5-7-21
29	Illustrative examples on Wattmeter Readings.		BB	1	32	6-7-21
MODULE 3:Single Phase Transformers & Domestic Wiring						
30	**Single Phase Transformers:** Necessity of transformer, Principle of operation.	L+D	BB	1	33	7-7-21
31	Types and Construction of transformers	L+D	BB	1	34	8-7-21
32	Emf equation, losses, variation losses with respect to load,	L+D	BB	1	35	9-7-21
33	Efficiency, Condition for maximum efficiency	L+D	BB	1	36	12-7-21
34	Illustrative problems on emf equation	L+D	BB	1	37	13-7-21
35	Illustrative problems on EFFICIENCY and Emf equation	L+PS	BB	1	38	14-7-21
36	**Domestic wiring:** Service mains, meter board and distribution board. Concealed conduit wiring.	L+D	LCD	1	39	15-7-21
37	Two-way and three-way control. fuse and Miniature Circuit Breaker	L+D	LCD	1	40	16-7-21
38	Electric shock, precautions against shock,	L+D	LCD	1	41	17-7-21
39	Understanding of earthing ,pipe and plate earthing	L+D	LCD	1	42	19-7-21
MODULE 4:DC Generators and DC Motors						
40	**DC Generators:** Principle of operation	L+AV	LCD	1	43	20-7-21

41	construction of DC generators	L+AV	LCD	1	44	22-7-21
42	Expression for induced EMF, types of DC generators	L+D	BB	1	45	23-7-21
	Internal Assessment II			1	46	27-7-21
43	Expression for induced EMF, types of DC generators	L+D	BB	1	47	29-7-21
44	Relation between induced emf and terminal voltage	L+D	BB	1	48	30-7-21
45	Illustrative examples on DC generator	L+PS	BB	1	49	31-7-21
46	DC Motors: Operation of DC motor, back emf,	L+AV	LCD	1	50	2-8-21
47	Derivation of Torque equation, Types of DC motors	L+D	BB	1	51	3-8-21
48	characteristics of DC motors and applications	L+D	LCD	1	52	4-8-21
49	Illustrative examples on DC motors	L+PS	BB	1	53	5-8-21
MODULE 5: Three phase synchronous generator and Three phase induction motor						
50	**Three Phase Synchronous Generators:** Principle of operation, constructional details	L+D	LCD	1	54	6-8-21
51	Synchronous speed, Frequency of Generated voltage,	L+D	BB	1	55	9-8-21
52	Derivation of Emf equation Concept of winding factor	L+D	BB	1	56	11-8-21
53	Illustrative examples	L+PS	BB	1	57	13-8-21
54	**Three Phase Induction Motors:** Principle of operation,	L+D	LCD	1	58	16-8-21
55	Generation of rotating magnetic field. Construction	L+D	BB	1	59	18-8-21
56	slip and its significance.	L+V	LCD	1	60	19-8-21
57	Necessity of a starter, star delta starter.	L+D	BB	1	61	23-8-21
58	Illustrative examples	L+D	BB	1	62	25-8-21
59	**Internal Assessment III**			1	63	27-8-21
60	Revision	L+D	BB	1	64	3-9-21
61	Revision	L+D	BB	1	65	4-9-21

Text Books: -

1. Basic Electrical Engineering, D C Kulshreshtha, Tata McGraw Hill, Revised First Edition.
2. Principles of Electrical Engineering & Electronics, V.K. Mehta, Rohit Mehta, S.Chand Publications.

Reference Books:

1. Fundamentals of Electrical Engineering and Electronics, B. L. Theraja, S. Chand & Company Ltd, Reprint Edition 2013.
2. Electrical Technology, E. Hughes, International Students 9th Edition, Pearson, 2005
3. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, 2017

WEB MATERIALS:

W1:http://www.nptelvideos.in/2012/11/basic-electrical-technology.html.
W2: https://nptel.ac.in/courses/Webcourse /IIT Kharagpur.

W3: http://nptel.ac.in.--Lecture Series on Basic Electrical Technology by Prof. L.Umanand, Principal Research Scientist, Power Electroniocs Group, CEDT and IISc, Bangalore.
W4:IEEE Transactions on Power Apparatus and Systems.
W5: Journal of the Institution of Electrical Engineers.
W6: Electrical Engineering journal.

Details of the teaching Aids

1. Blackboard
2. Overhead Projector –PPTs
3. Quizzes

Course Incharge

Module Coordinator

Signature of HOD

K.S.Institute of Technology, Bangalore

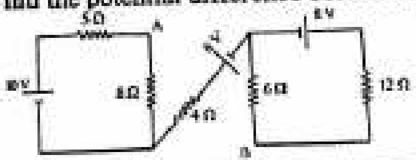
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

ASSIGNMENT QUESTIONS

Academic Year	**2020-21**		
Batch	**2019-2023**		
Year/Semester/section	**I/II/D & E**		
Course Code-Title	**18ELE23-Basic Electrical engineering**		
Name of the Instructor	**Vishalini Divakar**	**Dept**	**ECE**

Assignment No: 1
Date of Issue: 22/6/2020

Total marks:10
Date of Submission: 1/7/2020

Sl. No.	**Assignment Questions**	**K Level**	**CO**	**Marks**
1.	State and explain KVL & KCL as applicable to DC circuits.	**K2 Understanding**	**1**	**1**
2.	Two resistors connected in parallel across 100V DC supply. The total current from the supply source is 15A.The power dissipated in one resistor is 800W. Solve for the current drawn when they are connected in series across the same supply.	**K3 Applying**	**1**	**1**
3.	Find the potential difference between the points A and B in the network shown. 	**K3 Applying**	**1**	**1**
4.	Explain the RMS value and average value of sinusoidal quantity and derive the expression for the same. And hence obtain form factor and peak factor.		**1**	**1**
5.	An alternating current i is given by i=100 sin314t. Solve for(i) Amplitude (ii) Frequency (iii) Time period (iv) RMS value(v) Average value (vi) Instantaneous value when time t is 5milliseconds.(vii)Form factor (viii) Peak factor	**K3 Applying**	**1**	**1**
6.	A resistance R is connected in series with a parallel circuit comprising of two resistors of 10 Ω and 15 Ω. The total power dissipation in circuit is 100W when the applied voltage is 25 V. calculate R.	**K3 Applying**	**1**	**1**
7.	Show that current lags the applied voltage by 90^0 in a purely inductive A.C circuit and also power consumed is zero.	**K3 Applying**	**2**	**1**
8.	The current drawn by a pure capacitor of 20uF is 1.382A from a 220V AC supply. Find the supply frequency.	**K3 Applying**	**2**	**1**
9.	Derive the expression for the power consumed in a series RC circuit. Draw the relevant waveforms and vector diagram.	**K3 Applying**	**2**	**1**
10.	A circuit consists of a resistance of 10ohm and an inductance of 0.05H connected in series across an AC supply of 230V at 50 Hz. Solve for the Impedance, Current, Power consumed and power factor of the circuit. Also draw the vector diagram.	**K3 Applying**	**2**	**1**

HOD

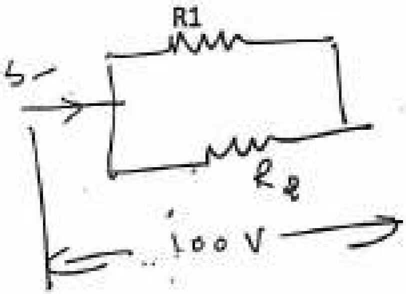
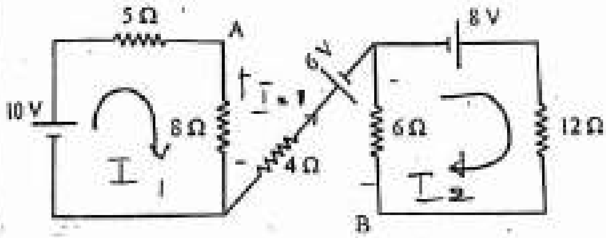
Course in charge

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

2020 – 21 EVEN SEMESTER

SCHEME AND SOLUTION-ASSIGNMENT1

Degree : B.E **Semester/Sec** : II/ D&E
Branch : ELECTRONICS & COMMUNICATION ENGG **Course Code** : 18ELE23
Course Title : BASIC ELECTRICAL ENGG **Max Marks** : 30

Q. No.	POINTS	Marks
1	Statement + ckt + explanation of KVL KCL	+ 1 + 1
2	$R_1 = \frac{V}{I_1} = 12.5\,\Omega$  $I_1 = \frac{100}{12.5} = 8A$ $I_2 = 7A \quad R_2 = \frac{100}{7} = 14.28\,\Omega$ when they are in series $I = \frac{100}{12.5 + 14.28} = 3.734\ A$	1 1 1
3	 $I_1 = \frac{10}{13} = 0.769A \quad I_2 = \frac{8}{18}$	1 1

= 0.444A

$V_{AB} = -6I_2 + 6 + 8I_1 = 9.482$ V

4 Rms & Average values - Definitions 1

$I_{rms} = \frac{I_m}{\sqrt{2}}$ $I_{av} = \frac{2I_m}{\pi}$ deriving

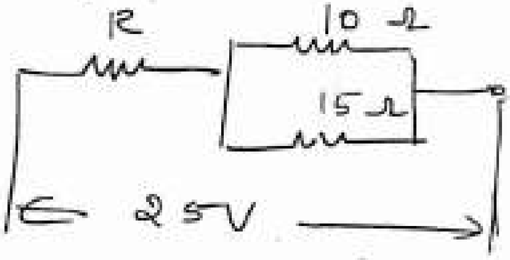
Form factor = 1.11 Peak factor = 1.414

5 i) Amplitude = I_m = 100 A ii) f = 50 Hz 1

iii) T = 0.02 sec (iv) Rms value I_{rms} = 70.7 A 1

(v) I_{av} = 63.7 A (vi) 100A (vii) t = 3.56 m sec 1

ix) K_f = 1.111 K_p = 1.414 1

6 

P = 100 W

$R_{eq} = \frac{V^2}{P} = \frac{25^2}{100}$

R_{eq} = 6.25 Ω

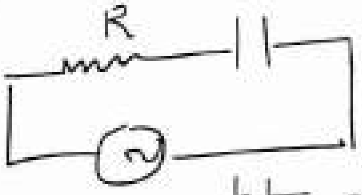
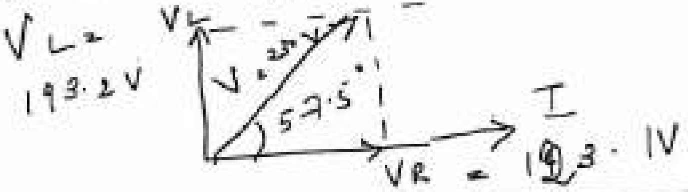
$R_p = \frac{10 \times 15}{25} = 6\ \Omega$ ∴ R = 6.25 - 6 = 0.25 Ω 1

7 Current thro' pure inductor $i = I_m \sin(\omega t + \frac{\pi}{2})$

Power explaining + derivation equation 1 +

vectors + wave forms 1

C = 20 µF I = 1.382A V = 220V

8	$X_c = \frac{220 \Omega}{1.38} = 159.19 \Omega$ = 50 H $X_c = \frac{1}{2\pi f c}$ ... = $2\pi X_c$	1 1
9	Series R-C ckt $i = I_m \sin(\omega t + \phi)$  ckt diagram ckt + explain + V.D + current equation power equation $P = VI\cos\phi$ + waveforms	1 1 1
10	Impedance 1) Z = 10 + j 15.7 Ω = 18.614 $\angle 57.5°$ Ω 2) current I = 12.36 $\angle -57.5°$ A 3) power = P = 1526.94 ω 4) cos ϕ = 0.5372 lag  	

Course in charge

HOD

N

K.S.Institute of Technology, Bangalore

DEPARTMENT OF
ELECTRONICS & COMMUNICATION ENGINEERING
ASSIGNMENT QUESTIONS

Academic Year	2020-21		
Batch	2020-2024		
Year/Semester/section	I/II/D & E		
Course Code-Title	18ELE23-Basic Electrical engineering		
Name of the Instructor	Vishalini Divakar	Dept	ECE

Assignment No: 2 **Total marks:10**

Date of Issue: 25/8/2021 **Date of Submission: 3/9/2021**

Sl. No.	Assignment Questions	K Level	CO	Marks
1.	Relate the line and phase quantities in a three phase balanced star connected system.	K2 Understanding	2	1
2.	Prove that the two watt meters are sufficient to measure power and power factor in a 3 phase balanced load.	K3 Applying	2	1
3.	Develop the EMF equation of single phase transformer.	K3 Applying	3	1
4.	With a neat sketch, **Illustrate** 2-way control of Lamp.	K2 Understanding	3	1
5.	A 200kVA, 10000V/400V ,50Hz single phase transformer has 100 turns on the secondary. Calculate i) The primary and the secondary currents ii) The no. of primary turns iii) The maximum value of flux.	K3 Applying	3	1
6.	In a 40kVA, transformer, the iron and copper losses are 450Watts and 850 Watts respectively. Calculate the efficiency at 0.8p.f.on a) Full load b) Half full load.	K3 Applying	3	1
7.	**Identify** the principle of working of a single phase transformer.	K3 Applying	3	1
8.	With a neat sketch, **Illustrate** 3-way control of Lamp.	K2 Understanding	3	1
9.	**Derive** the E.m.f. equation of a DC Generator.	K3 Applying	4	1
10.	An 8 pole generator has 500 armature conductors and has a useful flux per pole of 0.065 wb. **Calculate** the e.m.f. generated if it is lap connected and runs at 1000 r.p.m? What must be the speed at which it is to be driven to produce the same e.m.f. if it is wave wound?	K3 Applying	4	1

Course in charge

HOD 24/8

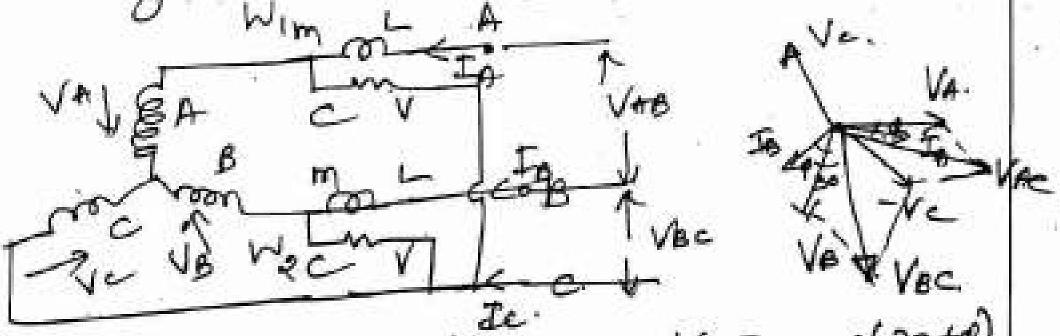
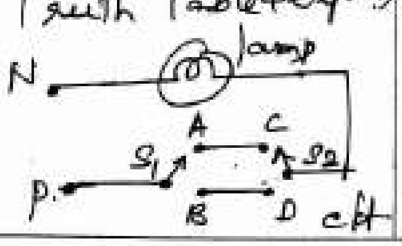
K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

ASSIGNMENT II- 2020 – 21 EVEN SEMESTER

SCHEME AND SOLUTION

Degree : B.E
Branch : ELECTRONICS & COMMUNICATION
Course Title : BASIC ELECTRICAL ENGG.

Semester : II D &E
Course Code : 18ELE23
Max Marks : 10

Q.NO	POINTS	MARKS
1.	Star connected load. → ckt diagrm + vectordiagm. Derive $I_L = I_{ph}$ $V_L = \sqrt{3} V_{ph}$.	1.
2.	ckt diagrm. + vector diagm. + derivation  $W_1 = V_L I_L \cos(30-\phi)$ $W_2 = V_L I_L \cos(30+\phi)$ $W_1 + W_2 = \sqrt{3} V_L I_L \cos\phi$, $\tan\phi = \sqrt{3}\frac{(W_1-W_2)}{W_1+W_2}$	
(3)	Emf equation → fig + explain + derive $E_1 = 4.44 f \phi_m N_1 = 4.44 f B_m A N_1$ volts $E_2 = 4.44 f \phi_m N_2 = 4.44 f B_m A N_2$ volts	
④	Two way control → fig + Truth Table + explain Truth Table 	

Truth Table

S_1	S_2	lamp
A	C	ON
A	D.	OFF.
B.	C	OFF
B	D.	ON

⑤ 200 kVA, 10000V/400V, $N_2 = 100$.

① $I_1 = \frac{kVA \times 10^3}{V_1} = \underline{\underline{20A}}$ $I_2 = \frac{KVA \times 10^3}{V_2} = \underline{\underline{500A}}$

② $\frac{E_2}{E_1} = \frac{N_2}{N_1}$ ∴ $N_1 = \underline{\underline{2500}}$. ③ $E_2 = 4.44 f \phi_m N_2$

$\phi_m = \underline{\underline{0.018 wb}}$

$\eta = \frac{x\, kVA \cos\phi \times 10^3 \times 100}{x\, kVA \cos\phi + W_i + x^2 W_{cu}}$

⑥ 40 kVA t_x

$w_i = 450w$

$w_{cu} = 850w$.

$\eta_{1} = \frac{1 \times 40 \times 0.8 \times 10^3 \times 100}{1 \times 40 \times 0.8 \times 10^3 + 450 + 850}$

$= \underline{\underline{96.09\%}}$

$\eta_{0.5} = 96.02\%$

⑦ working principle → fig + explain + k derivn

transformation ratio $k = \frac{N_2}{N_1} = \frac{E_2}{E_1} = \frac{I_1}{I_2}$

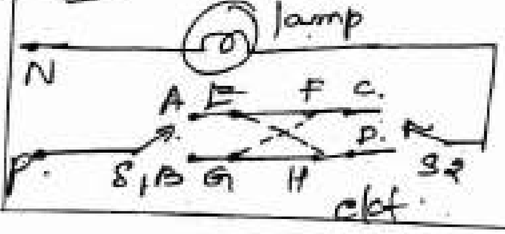
⑧ $\underline{\text{2 way control}}$ → fig ckt + Truthtable.

⑨ Emf eqn of a gen tr. $E_g = \frac{\phi Z N P}{60 A}$ derivn

⑩ ① $E_g = \frac{\phi Z N P}{60 A} = \frac{0.065 \times 500 \times 1000 \times 8}{60 \times 8} = \underline{\underline{541.67V}}$

② $\underline{N_2}$ 250 rpm when A = 2.

⑧.



straight			cross		
S_1	S_2	lamp	S_1	S_2	lamp
A	C	ON	A	C	OFF
A	D	OFF	A	D	ON
B	C	OFF	B	C	ON
B	D	ON.	B	D	OFF

course Incharge

H.O.D 29/8

KSIT Bangalore

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ASSIGNMENT QUESTIONS

Academic Year	2020-21		
Batch	2020-2024		
Year/Semester/section	I/II/D, E SEC		
Subject Code-Title	18ELE23-Basic Electrical Engg.		
Name of the Instructor	VD	Dept	ECE

Assignment No: 3
Date of Issue: 18/9/21

Total marks:10
Date of Submission: 26/9/21

Sl.No	Assignment Questions	K Level	CO	Marks
1.	A 6 pole 3Ø star connected alternator has an armature with 90 slots and 12 conductors per slot. It rotates at 1000rpm, the flux per pole being 0.5wb. **Calculate** the EMF generated. Take $K_d = 0.97$ and $K_c = 0.96$.	K3	CO5	1
2.	A 4 pole, 1500 rpm, star connected alternator has 9 slots/pole and 8 conductors per slot. **Solve** for the flux per pole to give a terminal voltage of 3300V. Take the winding factor as unity.	K3	CO5	1
3.	Drive the e.m.f equation of an alternator. Also give the expression for pitch factor and distribution factor.	K3	CO5	1
4.	**Show** how of rotating field is advantageous over rotating armature used in alternator.	K3	CO5	1
5.	**Illustrate** the principle of operation of an Induction motor and derive the equation for the slip.	K3	CO5	1
6.	**Differentiate** between squirrel cage and wound-rotor induction motors? Mention their applications.	K3	CO5	1
7.	With a neat sketch **explain** the construction of a dc generator.	K2	CO4	1
8	**Derive** the torque equation of DC Motor.		CO4	
9	A 4 pole, DC shunt motor takes 22.5 A from a 250 V supply . The armature resistance is 0.5 Ohms and field resistance is 125 Ohms. The armature is wave wound with 300 conductors. If the flux pet pole is 0.02 Wb. **Calculate** i) Speed ii) Torque developed iii) Power developed.	K3	CO4	1
10	A 200V,4 Pole , lap wound DC shunt motor has 800 conductors on its armature . The resistance of the armature winding is 0.5Ω and that of the shunt field winding is 200Ω. The motor takes 21A and flux /pole is 30mWb. **Solve for** speed and gross torque developed in the motor.	K3	CO4	1

Course In charge

HOD/ECE

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

ASSIGNMENT III- 2020 – 21 EVEN SEMESTER

SCHEME AND SOLUTION

Degree : B.E
Branch : ELECTRONICS & COMMUNICATION
Course Title : BASIC ELECTRICAL ENGG.

Semester : II- D &E
Course Code : 18ELE23
Max Marks : 10

Q.NO	POINTS	MARKS
1.	A 6 pole altr. $Z_{ph} = \frac{90\times12}{3} = 360.$ $E_{ph} = 2.22 f\phi Z_{ph} K_p K_d = 18605.38V.$ $E_L = \sqrt{3}E_{ph}$ $f = \frac{N_s P}{120} = \frac{1000\times6}{120} = 50Hz$ $E_L = 32,225.5V$	1m.
②	$Z_{ph} = \frac{9\times4\times8}{3} = 96.$ $N_s = 1500$ rpm. $f = \frac{N_s P}{120} = 50Hz.$ $E_{ph} = \frac{3300}{\sqrt{3}} = 2.22\times50\times\phi\times96\times1$ $\therefore \phi = 0.178wb$	— 1M
③.	Emf eqn.– Derive $E_{ph} = 2.22 f\phi Z_{ph} K_p K_d.$ $E_L = \sqrt{3}\,E_{ph}.$ $K_p = \cos\beta/2$ $K_d = \frac{\sin\left(\frac{m\alpha}{2}\right)}{m\sin\alpha/2}$	1.M
4)	write 5 advantages of rotating field	1.M
5)	Principle of operation → 3 figs. → with stator magnetic field, Rotor current + both. Derive slip = $s = \frac{N_s - N}{N_s}$	1 m
6)	write 5 differences betn. SC Im & wound rotor Im	1m.

1.	A. 6 pole altr: $Z_{ph} = \frac{90\times12}{3} = 360$. $E_{ph} = 2.22 f\phi Z_{ph} k_p k_d = 18605.38V$. $E_L = \sqrt{3}E_{ph}$ $f = \frac{N_s P}{120} = \frac{1000\times6}{120} = 50Hz$ $E_L = 32,225.5V$	1m.
②	$Z_{ph} = \frac{9\times4\times8}{3} = 96$. $N_s = 1500$ rpm. $f = \frac{N_s P}{120} = 50Hz$. $E_{ph} = \frac{3300}{\sqrt{3}} = 2.22\times50\times\phi\times96\times1$ $\therefore \phi = 0.178wb$	1M
③.	Emf equn.- Derive $E_{ph} = 2.22 f\phi Z_{ph} k_p k_d$. $E_L = \sqrt{3}\,E_{ph}$. $k_p = \cos\beta/2$ $k_d = \frac{\sin\left(\frac{m\alpha}{2}\right)}{m \sin\alpha/2}$	1.M
4)	write 5 advantages of rotating field	1.M
5)	Principle of operation →3figs. → with stator magnetic field, Rotor current + both. Derive slip = $s = \frac{N_s - N}{N_s}$	1. m
6)	write 5 differences betn. SC Im & wound rotor Im	1m.

7)	Construction – fig + parts → Rotor → Armature → stator → field syst Armature → core + winding → function + material Field system → yoke + poles + field windg + commutator + brushes → function + material	1 m.
8)	Torque equation $T_a = F \times r$. workdone $W = \frac{2\pi N T_a}{60}$ $\therefore T_a = 0.159 \frac{\phi Z P}{A} I_a$ N mt $T_a = 0.063 \frac{\phi Z P}{A} I_a$ kg mt	1 m.
9)	$I_{sh} = \frac{V}{R_{sh}} = 2A$ $I_a = I - I_{sh} = 20.5A$ $E_b = V - I_a R_a = 239.75V$. $N = \frac{E_b \times 60A}{\phi Z P}$ $N = 1198.75$ rpm. $T_a = 39.11$ Nm $= \frac{\phi Z P I_a}{A} (0.159)$. Power $P_a = E_b I_a = 4914.88$ watts	1M.
10).	$I_{sh} = \frac{V}{R_{sh}} = 1A$ $I_a = I - I_{sh} = 20A$. $E_b = V - I_a R_a = 190V$. $N =$ $N = \frac{E_b \times 60A}{\phi Z P} = 475$ rpm $T_a = 0.159 \frac{\phi Z P I_a}{A} = 76.32$ Nmt	1M.

Course Incharge

HOD

K.S.INSTITUTE OF TECHNOLOGY, BANGALORE-560109
I SESSIONAL TEST QUESTIONPAPER 2020–21 EVEN SEMESTER

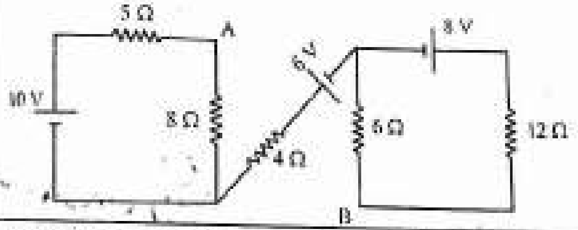
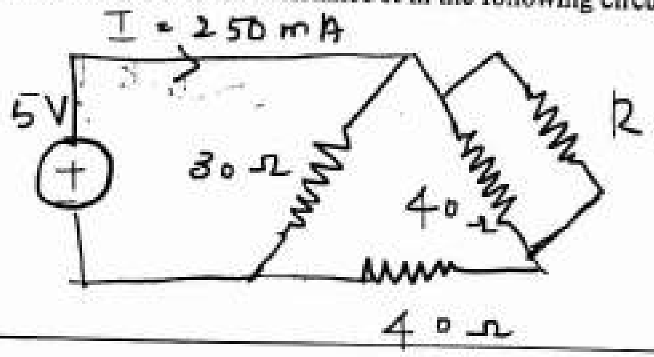
USN ☐☐☐☐☐☐☐☐☐☐

SetA

Degree : B.E
Branch : Electronics&CommunicationEngg
SubjectTitle : Basic Electrical Engineering
Duration : 90Minutes

Semester/Sec : II / D&E
SubjectCode : 18ELE23
Date : 29.06.2021
MaxMarks : 30

Note:Answer ONE full questionfrom each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	State and **explain** KVL & KCL as applicable to DC circuits.	6	CO1	K2 Understanding
(b)	**Find** the potential difference between the points A and B in the network shown.  	6	CO1	K3 Applying
(c)	**Find** the value of the resistance R in the following circuit.  	6	CO1	K3 Applying
	OR			
2(a)	**Explain** the RMS value and average value of sinusoidal quantity and derive the expression for the same. And hence obtain form factor and peak factor.	6	CO1	K2 Understanding
(b)	An alternating current i is given by i=100sin314t. **Solve for** (i) Amplitude (ii) Frequency (iii) Time period (iv) RMS value(v) Average value (vi) Instantaneous value when time t is 5milliseconds.(vii)Form factor (viii) Peak factor ix) Time when the current will be 90A.	6	CO1	K3 Applying
(c)	A resistance R is connected in series with a parallel circuit comprising of two resistors of 10 Ω and 15 Ω. The total power dissipation in circuit is 100W when the applied voltage is 25 V. **calculate** R.	6	CO1	K3 Applying
	PART-B			
3(a)	**Show that** current lags the applied voltage by 90^0 in a pure inductive A.C circuit and also power consumed is zero.	6	CO2	K3 Applying

(b)	The current drawn by a pure capacitor of 20uF is 1.382A from a 220V AC supply. **Find** the supply frequency.	6	CO2	K3 **Applyin**
OR				
4(a)	**Show that** power consumed in an series R-C circuit is $P = VI\cos\phi$, where V is RMS value of the applied voltage, I is the RMS value of current and ϕ is the angle between voltage V and current. Also draw the relevant phasor diagrams and waveforms.	6	CO2	K3 **Applying**
(b)	A circuit consists of a resistance of 10ohm and an inductance of 0.05H connected in series across an AC supply of 230V at 50 Hz. **Solve for the** Impedance, Current, Power consumed and power factor of the circuit. Also draw the vector diagram.	6	CO2	K3 **Applying**

All of you please mail the scanned PDF copy of the answer script to the mail id **beeassignmentf@gmail.com**

Signature ofCourse in charge

Signature of Module coordinator

Signature of HOD
I/c

Signature of the Principal

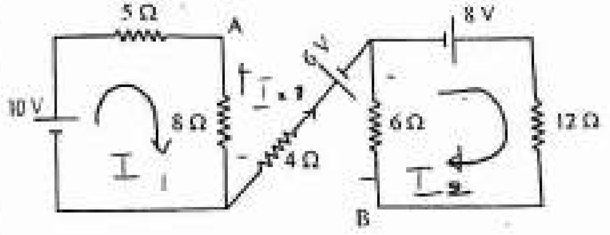
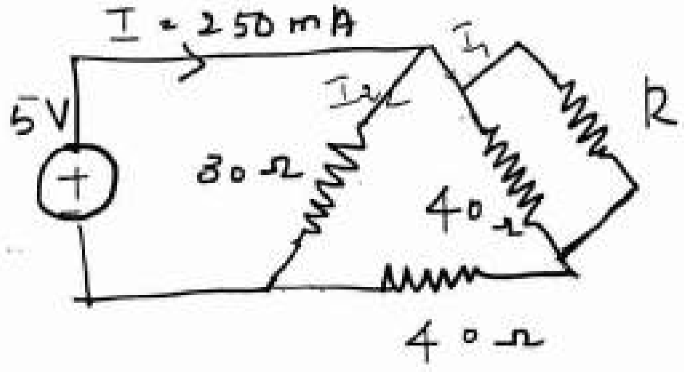
Selected

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

I SESSIONAL TEST QUESTION PAPER 2020 – 21 SEMESTER

SCHEME AND SOLUTION-SET A

Degree : B.E
Branch : ELECTRONICS & COMMUNICATION ENGG
Course Title : BASIC ELECTRICAL ENGG
Semester/Sec : II/ D&E
Course Code : 18ELE23
Max Marks : 30

Q. No.	POINTS	Marks
1 a)	Statement + ckt + explanation of KVL KCL	$(1+1+)\times 2$ = 6 M
(b)		
	$I_1 = \frac{10}{18} = 0.769A$ $I_2 = \frac{8}{18}$ $= 0.444A$	2+2 M 6 M
	$V_{AB} = -6I_2 \mid 6 + 8I_1 = 9.482$ V	2M
(c)	Find the value of the resistance R in the following circuit.  $R_p = R \parallel 40$ $R_{eq} = \frac{5}{250 \times 10^{-3}}$ $= 20\ \Omega$	1M 1 M

$R_{eq} = (R_p + 40) \parallel 30 = 20$

$R_p = \frac{40R}{40+R} = 20\,\Omega \quad \therefore R = 40\,\Omega$ (2+2)M

2(a) Rms & Average values - Definitions 1M

$I_{rms} = \frac{I_m}{\sqrt{2}} \quad I_{av} = \frac{2I_m}{\pi}$ deriving 4M

Form factor = 1.11 Peak factor = 1.414 1M

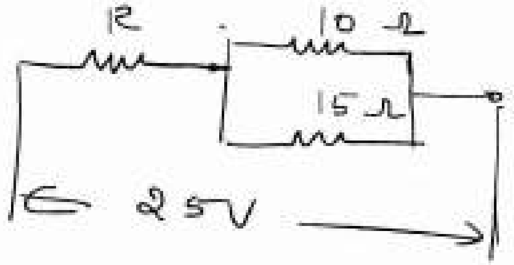
(b) i) Amplitude = I_m = 100 A ii) f = 50 Hz 1M

iii) T = 0.02 sec (iv) Rms value I_{rms} = 70.7 A 2M

(v) I_{av} = 63.7 A (vi) 100A (vii) t = 3.56 m sec 2M

ix) k_f = 1.111 k_p = 1.414 1M

(c)



P = 100 W

$R_{eq} = \frac{V^2}{P} = \frac{25^2}{100}$

$R_{eq} = 6.25\,\Omega$ 2M

$R_p = \frac{10 \times 15}{25} = 6\,\Omega \quad \therefore R = 6.25 - 6 = 0.25\,\Omega$ 2+2

3)

a) Current thr' pure inductor $i = I_m \sin(\omega t + \pi/2)$

ckt + explain + current equation 1+2

Power = 0 - derivation 2 M

vectors + wave forms 1 M

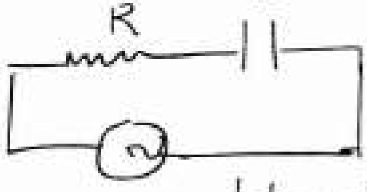
3 b) C = 20 μF I = 1382A V = 220V

$X_c = \frac{220}{1.382} = 159.19\ \Omega$ 3M

$X_c = \frac{1}{2\pi f C}$ ∴ $f = \frac{1}{2\pi X_c} = 50\ Hz$ 3 M

4 a) Series R-C ckt

i = Im Sin(ωt+φ)



kt diagm

ckt + explain + V.D + current equation 1 X 4M

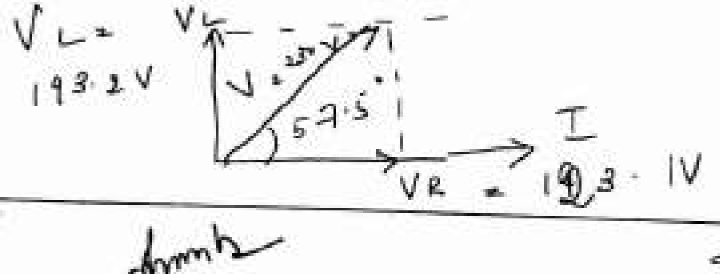
power equation P = VI cos φ + wave forms (1+1) M

4 b) Impedance 1) Z = 10 + j 15.7 Ω

= 18.614 ∠57.5° Ω

2) current I = 12.36 ∠-57.5° A

3) power = P = 1526.94 W 4) cos φ = 0.5372 lag



Course in charge Module coordinator HOD I/C

K.S.INSTITUTEOFTECHNOLOGY,BANGALORE-560109
I SESSIONAL TEST QUESTIONPAPER 2020–21 EVEN SEMESTER

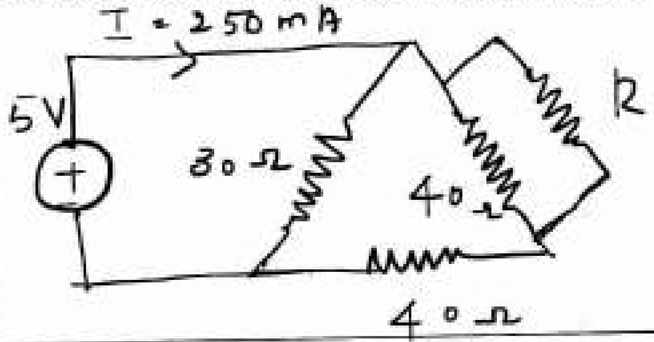
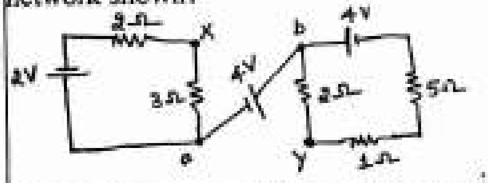
USN ☐☐☐☐☐☐☐☐☐☐

SetB

Degree : B.E
Branch : Electronics&CommunicationEngg
SubjectTitle : Basic Electrical Engineering
Duration : 90Minutes

Semester : II-D&E
SubjectCode : 18ELE23
Date : 29.06.2021
MaxMarks : 30

Note:Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	**Explain** the RMS value and average value of sinusoidal quantity and derive the expression for the same. And hence obtain form factor and peak factor.	6	CO1	K2 Understanding
(b)	An alternating current i is given by i=141.4 sin314t. **Solve for**(i) Amplitude (ii) Frequency (iii) Time period (iv) RMS value(v) Average value (vi) Instantaneous value when time t is 3milliseconds.(vii)Form factor and Peak factor ix) Time when the current will be 100A	6	CO1	K3 Applying
(c)	Find the value of the resistance R in the following circuit.  	6	CO1	K3 Applying
	OR			
2(a)	State and **explain** KVL & KCL as applicable to DC circuits.	6	CO1	K2 Understanding
(b)	**Identify**the potential difference between the point X and Y in the network shown?  	6	CO1	K3 Applying
(c)	Two resistors connected in parallel across 100V DC supply. The total current from the supply source is 15A.The power dissipated in one resistor is 800W. **Solve** for the current drawn when they are connected in series across the same supply.	6	CO1	K3 Applying
	PART-B			
3(a)	**Show that** current lags the applied voltage by 90° in a pure capacitive A.C circuit and also power consumed is zero.	6	CO2	K3 Applying

(b)	The current drawn by a pure capacitor of 20uF is 1.382A from a 220V AC supply. **Find** the supply frequency.	**6**	**CO2**	**K3** **Applying**
	OR			
4(a)	A circuit consists of a resistance of 25ohm and Capacitance of 100uF connected in series across an AC supply of 200V at 50 Hz. **Solve for** the Impedance, Current, Power consumed and power factor of the circuit.	**6**	**CO2**	**K3** **Applying**
(b)	**Show that** power consumed in an series R-L circuit is P = VIcosϕ, where V is RMS value of the applied voltage, I is the RMS value of current and ϕ is the angle between voltage V and current. Also draw the relevant phasor diagrams and waveforms.	**6**	**CO2**	**K3** **Applying**

All of you please mail the scanned PDF copy of the answer script to the mail id **beeassignmentf@gmail.com**

Signature of Course in charge

Signature of Module coordinator

Signature of HOD

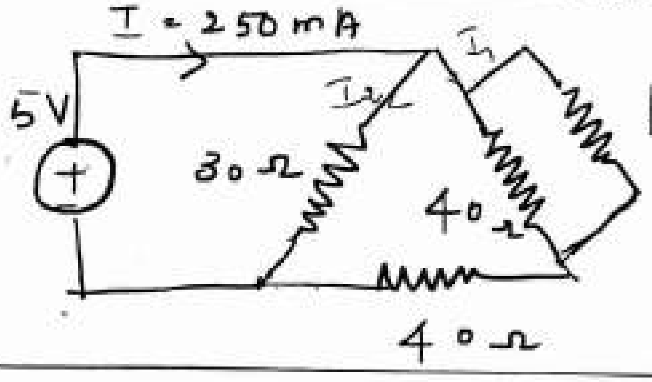
Signature of the Principal

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

I SESSIONAL TEST QUESTION PAPER 2020 – 21 SEMESTER

SCHEME AND SOLUTION-SET B

Degree : B.E
Branch : ELECTRONICS & COMMUNICATION ENGG
Course Title : BASIC ELECTRICAL ENGG
Semester/Sec : II/ D&E
Course Code : 18ELE23
Max Marks : 30

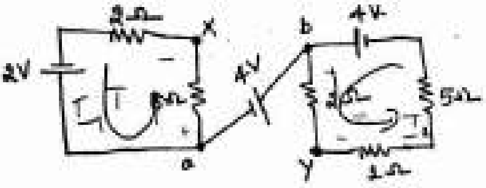
Q. No.	POINTS	Marks
1 a)	Rms & Average values - Definitions	1 M
	$I_{rms} = \frac{I_m}{\sqrt{2}}$ $I_{av} = \frac{2I_m}{\pi}$ deriving	4 M
	Form factor = 1.11 Peak factor = 1.414	1M
(b)	Amplitude Im = 141.4 A	½ M
	f = 50 Hz T = 0.02 sec i = 114.35 A (1M)	1+1 M
	t = 2.5 msec Irms = 100 A	1 + ½ M
	Iav = 90 A Kf = 1.11 kp = 1.414	2 M
(c)	Find the value of the resistance R in the following circuit.  $R_p = R \parallel 40$ $R_{eq} = \frac{5}{250 \times 10^{-3}}$	

$R_{eq} = (R_p + 40) \parallel 30 = 20\,\Omega$ 2 M

$R_p = \frac{40R}{40+R} = 20\,\Omega \quad \therefore R = 40\,\Omega$ (2+2)M

Statement + ckt + explanation {KVL, KCL} 1+1+1, 1+1+1 } 6 M

2 (b) Identifythe potential difference between the point X and Y in the network shown?

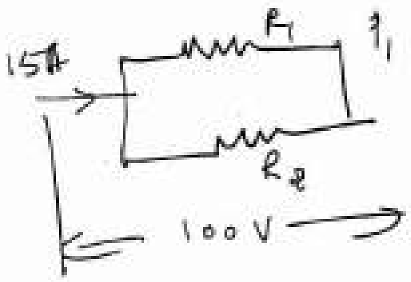


$I_1 = \frac{2}{5} = 0.4\,A$

$I_2 = \frac{4}{8} = 0.5\,A$

$V_{xy} = 2I_2 - 4 - 2I_1 = \underline{\underline{-3.8\,V}}$

(c) $R_1 = \frac{V^2}{P_1} = 12.5\,\Omega$



$P_1 = 800\,W$

$I_1 = \frac{100}{12.5} = 8\,A$

$I_2 = 7\,A \quad R_2 = \frac{100}{7} = 14.28\,\Omega$

when they are in series

$I = \frac{100}{12.5 + 14.28} = \underline{\underline{3.734\,A}}$

3 a) Current thr' pure. resistor $i = I_m \sin(\omega t + \quad)$

ckt + explain + current equation 1+ 2

Power $p = 0$ - derivation — 22M

vectors + wave forms — 1M M

3 b) $C = 20\mu F$ $I = 1.382A$ $V = 220V$

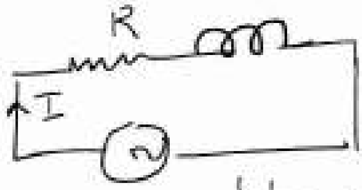
$X_c = \frac{220}{1.382} = 159.19\Omega$ — 3M

ZZ

$X_c = \frac{1}{2\pi f C}$ $\therefore f = \frac{1}{2\pi X_c} = 50 Hz$ — 3 M

4 a) Series R- ckt L

$i = I_m \sin(\omega t - \phi)$



ckt diagm

ckt + explain + V.D + current equation — 1 X 4M

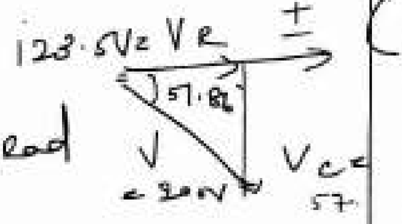
power equation $P = VI\cos\phi$ + wave forms — (1+1)M

b) $Z = R - jX_c$ $X_c = 31.84\Omega$

$Z = 25 - j31.84 = 40.48 \angle{-51.86^\circ}\Omega$

$I = \frac{V}{Z} = 4.94 \angle{51.84}$ — 1M

$P = 610.17 w$ $\cos\phi = 0.617$ lead — 1.M



1.x 4 M

3 V

Course in charge

Module coordinator

HOD
I/C

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109
II SESSIONAL TEST QUESTION PAPER 2020 – 21 EVEN SEMESTER

SET – A

USN										

Degree : B.E
Branch : Electronics and Communication Engg
Course Title : Basic Electrical Engg.
Duration : 90 Minutes

Semester : II-D&E
Course Code : 18ELE23
Date : 31/08/21
Max Marks : 30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	**Develop** EMF equation of single phase transformer.	6	CO3	K3 Applying
(b)	With a neat sketch, **Illustrate** 2-way control of Lamp.	6	CO3	K2 Understanding
(C)	A 200kVA, 10000V/400V ,50Hz single phase transformer has 100 turns on the secondary. **Calculate** i) The primary and the secondary currents ii) The no. of primary turns iii) The maximum value of flux. iv) Emf induced per turn.	6	CO3	K3 Applying
	OR			
2(a)	In a 40kVA, transformer, the iron and copper losses are 450Watts and 850 Watts respectively. **Calculate** the efficiency at 0.8p.f.on a) Full load b) Half full load.	6	CO3	K3 Applying
(b)	With a neat sketch, **Illustrate** 3-way control of Lamp.	6	CO3	K2 Understanding
(C)	**Identify** the principle of working of a single phase transformer.	6	CO3	K3 Applying
	PART-B			
3(a)	**Obtain** the relationship between the line and phase quantities in a three phase balanced star connected system.	6	CO2	K3 Applying
(b)	**Derive** the E.m.f. equation of a DC Generator.	6	CO4	K3 Applying
	OR			
4(a)	**Prove that** the two watt meters are sufficient to measure power and power factor in a 3 phase balanced load.	6	CO2	K3 Applying
(b)	An 8 pole lap connected armature has 40 slots with 12 conductors per slot generates a voltage of 500V. **Determine** the speed at which it is running if the flux per pole is 50mwb.	6	CO4	K3 Applying

Course in charge

Module Coordinator

HOD

Principal

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

2020 – 21 EVEN SEMESTER

SCHEME AND SOLUTION-IA2-SET A

Degree : B.E
Branch : ELECTRONICS & COMMUNICATION ENGG
Course Title : BASIC ELECTRICAL ENGG
Semester/Sec : II/ D&E
Course Code : 18ELE23
Max Marks : 30

Q. No.	POINTS	Marks
①	ⓐ Derive Emf equation $E_1 = N_1\frac{d\phi}{dt}$ $E_1 = 4.44 f \phi_m N_1$ $E_2 = -N_2\frac{d\phi}{dt}$ $E_2 = 4.44 f \phi_m N_2$	6 m.
(b)	2 way control → ckt diagram + truth table + explain	2×3 = 6 m.
(c)	200 kVA. 10000V / 400V. $N_2 = 100$. ① $I_1 = \frac{kVA \times 10^3}{V_1} = 20A$. $I_2 = \frac{kVA \times 10^3}{V_2} = 500A$. ② $\frac{10000}{400} = \frac{N_1}{100}$. $N_1 = 2500$ ③ $\phi_m = 0.018 wb$. $E_2 = 4.44 f \phi N_2$. ④ $\frac{E_1}{N_1} = \frac{E_2}{N_2} = \frac{400}{100} = 4V$ / turn.	3. 3×1 = 6 m
②	ⓐ. 40kVA tr. $W_i = 450 W$ $W_{cu} = 850$ 0.8 pf. $\eta_1 = 96.09\%$ $\eta_{1/2} = 96.62\%$	3 + 3 } 6 m

②	ⓑ 2 way control → ckt diagm + truth table + explain	2×3 =6 m
	(c). working principle → fig + explain + transfor ratio	2×3 =6 m
③	ⓐ ckt diagm + vector diagm + derive $V_L = \sqrt{3} V_{ph}$ $I_L = I_{ph}$	2×3 =6 m
	(b). Emf eqn. $E_g = \frac{\phi Z N P}{60 A}$ derive	6 m
④	ⓐ 2 wattmeter method → $W_1 + W_2 = \sqrt{3} V_L I_L \cos\phi$ $\tan\phi = \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)$ ckt diagm + vector diagm	2 2×2 =6 m.
	ⓑ. $P = 8$. $A = P$ $E_g = 500V$ $\phi = 50 mwb$ $Z = 30 \times 12 = 360$. $E_g = \frac{\phi Z N P}{60 A}$ $500 = \frac{50 \times 10^{-3} \times 8 \times N \times 360}{60 \times 8}$ $N = 1666.67$ Nm	2. 4 =6 m

Course in charge

Module coordinator

HOD

1

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109
II SESSIONAL TEST QUESTION PAPER 2020 – 21 EVEN SEMESTER

SET – B

USN ☐☐☐☐☐☐☐☐☐☐

Degree : B.E
Branch : Electronics and Communication Engg
Course Title : Basic Electrical Engg.
Duration : 90 Minutes

Semester : II-D&E
Course Code : 18ELE23
Date : 31/09/21
Max Marks : 30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	With a neat sketch, **Illustrate** 3-way control of Lamp.	6	CO3	K2 Understanding
(b)	**Develop** the condition for Maximum Efficiency of a single phase transformer.	6	CO3	K3 Applying
(C)	In a 25kVA, 2000/200V transformer, the iron and copper losses are 350Watts and 400Watts respectively. **Calculate** the efficiency at U.p.f. on a) Full load b) Half full load.	6	CO3	K3 Applying
	OR			
2(a)	With a neat sketch, **Illustrate** 2-way control of Lamp.	6	CO3	K2 Understanding
(b)	**Identify** the principle of working of a single phase transformer.	6	CO3	K3 Applying
(C)	A 250 KVA, 11000V/415V, 50 Hz, single phase transformer has 80 turns on the secondary. **Calculate** i) Rated Primary and Secondary currents ii) The number of primary turns iii) The maximum value of flux iv) Voltage induced per turn.	6	CO3	K3 Applying
	PART-B			
3(a)	**Prove that** the two watt meters are sufficient to measure power and power factor in a 3 phase balanced load.	6	CO2	K3 Applying
(b)	**Derive** the E.m.f. equation of a DC Generator.	6	CO4	K3 Applying
	OR			
4(a)	**Obtain the** relationship between the line and phase quantities in a three phase balanced star connected system.	6	CO2	K3 Applying
(b)	An 8 pole generator has 500 armature conductors and has a useful flux per pole of 0.065 wb. **Calculate** the e.m.f. generated if it is lap connected and runs at 1000 r.p.m? What must be the speed at which it is to be driven to produce the same e.m.f. if it is wave wound?	6	CO4	K3 Applying

Course in charge **Module Coordinator** **HOD**

Principal

Selected

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

2020 - 21 EVEN SEMESTER

SCHEME AND SOLUTION-IA2-SET B

Degree : B.E
Branch : ELECTRONICS & COMMUNICATION ENGG
Course Title : BASIC ELECTRICAL ENGG
Semester/Sec : II/ D&E
Course Code : 18ELE23
Max Marks : 30

Q. No.	POINTS	Marks
(1)	ⓐ 3 way control. → ckt diagm + truthtable + explanation (2+2+2)	6 m
	(b) Derive Iron loss & Cu loss using eqn. $\eta = \frac{V_1 I_1 \cos\phi_1 - W_i - I_1^2 R_{01}}{V_1 I_1 \cos\phi_1}$	6 m.
	(c) (1) At full load, upf, $x = 1$ $\cos\phi = 1$ $\eta_1 = \frac{1\times25\times10^3\times1 \times100}{1\times25\times10^3\times1 + 350 + 1^2\times400} = 97.1\%$ ② $\eta_{1/2} = 96.52\%$	3 + 3 } 6 m
②	ⓐ 2 way control → ckt. diagm + truthtable + expln	2×3 = 6m
	ⓑ Principle → fig + Transformation ratio k + explain	2×3 = 6m.
	ⓒ $I_1 = 22.72A$ $I_2 = 602.41A$ $N_1 = 2122$. $\phi_m = 23.56$ mwb. $V/Turn = 5.2V/turn$	3 + 1×3 } 6.
③	Two wattmt method → ckt diagm + vector diagm + derivation. $W_1 + W_2 = \sqrt{3} V_L I_L \cos\phi$ $\tan\phi = \sqrt{3}\frac{(W_1 - W_2)}{(W_1 + W_2)}$	2×3 = 6

(b)	Derive $E = \frac{\phi Z N P}{60A}$ for a dc generator	6 m
④	ⓐ. ckt diagram + vector diagram + derivation (1) $V_L = \sqrt{3} V_{ph}$ (2) $I_L = I_{ph}$ (3) $P_y = \sqrt{3} V_L I_L \cos\phi$	2+2+ 2 = 6 m.
4. ⓑ (1)	$P = 8$ $Z = 500$ $\phi = 0.065$ wb. $A = P$ $N = 1000$ rpm $E_g = \frac{\phi Z N P}{60A} = \underline{\underline{541.667}}V$	
	(2) $A = 2$ wave connection. $E_g = 541.667 = \frac{0.065 \times 8 \times N \times 500}{60 \times 2}$ $\therefore N = \underline{\underline{250}}$ rpm	

Course in charge **Module coordinator** **HOD**

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109
III SESSIONAL TEST QUESTION PAPER 2020 – 21 EVEN SEMESTER

Set A

USN ☐☐☐☐☐☐☐☐☐☐

Degree : **B.E**
Branch : **Electronics & Communication Engg**
Subject Title : **Basic Electrical Engineering**
Duration : **90 Minutes**

Semester/Sec : **II / D & E**
Subject Code : **18ELE23**
Date : **22.09.2021**
Max Marks : **30**

Note: Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	**Identify** the advantages of having stationary armature in case of alternator.	6	CO5	Applying K3
(b)	**Develop** EMF equation of an alternator. Also give the expression for pitch factor and distribution factor.	6	CO5	Applying K3
(C)	A 6 pole 3Ø star connected alternator has an armature with 90 slots and 12 conductors per slot. It rotates at 1000rpm, the flux per pole being 0.5wb. **Calculate** the EMF generated. Take $K_d = 0.97$ and $K_p = 0.96$.	6	CO5	Applying K3
	OR			
2(a)	By means of neat diagram **illustrate** the constructional details of a three phase induction motor.	6	CO5	Applying K3
(b)	A 6 pole induction motor supplied from a 3 Ø 50Hz supply has a rotor frequency of 2.3 Hz. **Solve** for i) The percentage slip ii) The speed of the motor.	6	CO5	Applying K3
(C)	**Establish** the difference between squirrel cage and slip ring rotor Induction motors?	6	CO5	Applying K3
	PART-B			
3(a)	**Derive** the torque equation of a DC Motor.	6	CO4	Applying K3
(b)	A 4 pole, DC shunt motor takes 22.5 A from a 250 V supply . The armature resistance is 0.5 Ohms and field resistance is 125 Ohms. The armature is wave wound with 300 conductors. If the flux pet pole is 0.02 Wb. **Calculate** i) Speed ii) Torque developed iii) Power developed.	6	CO4	Applying K3
	OR			
4(a)	With a neat sketch **Illustrate** the construction of a dc machine.. What are the essential functions of the field coils, armature, commutator and brushes?	6	CO4	Applying K3
(b)	A 200V,4 Pole , lap wound DC shunt motor has 800 conductors on its armature . The resistance of the armature winding is 0.5Ω and that of the shunt field winding is 200Ω. The motor takes 21A and flux /pole is 30mWb.**Solve** for the speed and gross torque developed in the motor.	6	CO4	Applying K3

Course in charge　　**Module Coordinator**　　**HOD**　　**Principal**

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

2020 – 21 EVEN SEMESTER

SCHEME AND SOLUTION-IA3-SET A

Degree : B.E
Branch : ELECTRONICS & COMMUNICATION ENGG
Semester/Sec : II/ D&E
Course Title : BASIC ELECTRICAL ENGG
Course Code : 18ELE23
Max Marks : 30

Q. No.	POINTS	Marks
①	ⓐ 6 advantages of stationary armature -	6×1=6.
	ⓑ. Emf equation of altr. Derivation $E_{ph}=2.22 f\phi Z_{ph} k_p k_d$	-4 m
	$E_L=\sqrt{3}E_{ph}$	1 m
	$k_p=\cos\beta/2$ $k_d=\frac{\sin(m\alpha/2)}{m\sin(\alpha/2)}$	1 m } 6.
(c)	$Z_{ph}=\frac{90\times12}{3}=360$. $E_{ph}=2.22 f\phi Z_{ph}k_pk_d$	-1 m
	$f=\frac{N_s P}{120}=\frac{1000\times6}{120}=50Hz$	1 m
	$E_{ph}=18605.38V$. $E_L=32,225.45V$	-4 m } 6
②	ⓐ stator + Rotors (2 types) ~~stator~~ squirrel cage & phase wound rotor (Fig + explanation + function) → stator -	2
	Rotor 1 + Rotor 2	-2+2 } 4.
ⓑ	① S = 4.6 %. $f'=sf$ ②. $N=N_s(1-S)=954$ rpm	3+3. = 6 m
ⓒ.	6 differences betn. SCIM & slipring IM →	1×6 = 6 m

ⓐ. Torque equation $T_a = F \times r$ Derive.	1m
$P_a = \frac{2\pi N T_a}{60} = E_b I_a$	-4 } 6
∴ $T_a = 0.159\left(\frac{\phi Z P}{A}\right) I_a$ Nm.	-1m
ⓑ. $E_b = \frac{\phi Z N P}{60 A}$ $I_{sh} = \frac{V}{R_{sh}} = 2A$. $A=2$	-1.
$I_a = I - I_{sh} = 20.5A$ $E_b = V - I_a R_a = 239.75V$	-2
$N = \frac{E_b \times 60 \times A}{\phi Z P} = 198.75$ rpm	-1.
$T_a = \frac{\phi Z P}{A} (I_a)(0.159) = \underline{39.114}$ Nm	-1
Power $= E_b I_a = \underline{4914.88}$ watts.	-1
④ ⓐ. Construction → stator– field system ~~Rotor~~→ Armature	
Fig + explain + function.	3×2=6m
ⓑ. $I_{sh} = \frac{200}{200} = 1A$ $I_a = 21-1 = 20A$	1+1.
$E_b = V - I_a R_a = 200 - 20 \times 0.5 = 190V.$	-1.
$N = 475$ rpm. $T_a = 0.159 \frac{\phi Z P}{A} I_a$ ↑	-1+2.
$= 76.32$ Nm	

Course in charge

Module coordinator

HOD

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

III SESSIONAL TEST QUESTION PAPER 2020 – 21 EVEN SEMESTER

Set B

Degree	: B.E	**USN**	☐☐☐☐☐☐☐☐☐☐
Branch	: Electronics & Communication Engg	**Semester/Sec :**	II / D & E
Subject Title	: Basic Electrical Engineering	**Subject Code :**	18ELE23
Duration	: 90 Minutes	**Date :**	22.09.2021
		Max Marks :	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	**Illustrate** the concept of Rotating Magnetic Field in 3phase induction motor.	6	CO5	Applying K3
(b)	A 3 phase induction motor with 4 poles is supplied from an alternator having 6 poles and running at 1000rpm, calculate i) synchronous speed of the induction motor ii) it's speed when slip is 0.04	6	CO5	Applying K3
(C)	**Develop** the equation for the frequency of Rotor current of a 3 phase Induction Motor.	6	CO5	Applying K3
	OR			
2(a)	**Develop** EMF equation of an alternator. Also give the expression for pitch factor and distribution factor.	6	CO5	Applying K3
(b)	**Establish** the difference between salient pole and smooth cylindrical rotor Alternators?	6	CO5	Applying K3
(C)	A 4 pole, 1500 rpm, star connected alternator has 9 slots/pole and 8 conductors per slot. **Solve** for the flux per pole to give a terminal voltage of 3300V. Take the winding factor as unity.	6	CO5	Applying K3
	PART-B			
3(a)	With a neat sketch **Illustrate** the construction of a dc machine.	6	CO4	Applying K3
(b)	A 200V,4 Pole, lap wound DC shunt motor has 800 conductors on its armature The resistance of the armature winding is 0.5Ω and that of the shunt field winding is 200Ω. The motor takes 21A and flux /pole is 30mWb. **Solve** for speed and gross torque developed in the motor.	6	CO4	Applying K3
	OR			
4(a)	**Derive** the torque equation of a DC Motor.	6	CO4	Applying K3
(b)	A 4 pole, DC shunt motor takes 22.5 A from a 250 V supply .The armature resistance is 0.5 Ohms and field resistance is 125 Ohms. The armature is wave wound with 300 conductors. If the flux pet pole is 0.02 Wb. **Calculate** i) Speed ii) Torque developed	6	CO4	Applying K3

Course in charge　　**Module Coordinator**　　**HOD**　　**Principal**

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109

2020 – 21 EVEN SEMESTER

SCHEME AND SOLUTION-IA3-SET B

Degree : B.E

Branch : ELECTRONICS & COMMUNICATION ENGG

Semester/Sec : II/ D&E

Course Code : 18ELE23

Course Title : BASIC ELECTRICAL ENGG

Max Marks : 30

Q. No.	POINTS	Marks
①	ⓐ. Rotating mag field. $\phi_T = 1.5\phi_m$. Draw the vectors of ϕ_R, ϕ_Y, ϕ_B. for $\theta = 0$, 60°, 120°, 180°. & show that $\phi_T = 1.5\phi_m$	4+2 = 6 M
ⓑ.	$P_m = 4$. $P_A = 6$ $N_s = 1000$ $f = \frac{N_s P}{120} = 50Hz$	2 M
(i)	$N_{sm} = \frac{120f}{P} = 1500$ rpm	2 M
(ii)	$N = N_{sm}(1-s) = 1800(1-0.04) = 1440$ rpm	2 M } 6.
① ⓒ	Derive $N' = \frac{120f}{P}$ $N_s - N = \frac{120f'}{P}$	2
	$f' = sf$	4 M } 6.
②	ⓐ Emf equation $E_{ph} = 2.22 f \phi Z_{ph} K_p K_d$	4 M
	$E_L = \sqrt{3} E_{ph}$	1 M
	$K_p = \cos\beta/2$ & $K_d = \frac{\sin\left(\frac{m\alpha}{2}\right)}{m \sin\alpha/2}$	1 M } 6.
ⓑ	6 differences betn. salient pole & smooth cylindrical rotors. Altrs	6×1 = 6 M

2.(a)	$Z_{ph} = \frac{9 \times 4 \times 8}{3} = 96$. $N_s = 1500$ rpm $E_{ph} = \frac{3300}{\sqrt{3}} = 2.22 \times 50 \times \phi \times 96 \times 1$. $\phi = \underline{\underline{0.178}}$ wb $f = \frac{N_s P}{120} = \frac{1500 \times 4}{120} = 50Hz$ $K_p K_d = K_w = 1$.	– 2 – 2 (6m) – 2
③	ⓐ. Construction → stator – field system Rotor → Armature Fig + explain of function.	– 3 – 3 } 6m
	ⓑ. $I_{sh} = \frac{200}{200} = 1A$ $I_a = 20A$ $E_b = 190V$. $N = 975$ rpm $T_a = 76.32$ Nm	1+1+1 1+2 } 6m.
④	ⓐ. Torque equation $T_a = F \times r$. Derive $P_a = \frac{2\pi N T_a}{60} = E_b I_a$. $T_a = 0.159 \frac{\phi Z P}{A} I_a$ Nmt.	– 1 – 4 } 6. – 1
	ⓑ. $I_{sh} = 2A$ $I_a = 20.5A$ $E_b = 239.75V$. $N = 1198.75$ rpm, $T_a = 39.11$ Nmt Power $P_a = E_b I_a = 4914.88$ W.	1+1+1 1+1 } 6 1.

Course In charge

Module coordinator

HOD

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE
ARTMENT OF ELECTRONICS AND COMMUNICATION EN

Course:BASIC ELECTRICAL ENGG.	sem:II		sec:D				

Sl No.	USN No.	Name	IA1	IA2	IA3	A1	A2	A3	Average Assignment	Average of three IA's	Final IA(As signment +IA)	
1	1KS20EC001	ABHISHEK J	26	30	30	10	10	10	10	28.7	38.7	39
2	1KS20EC002	ADITI DUBEY	30	30	30	10	10	10	10	30.0	40.0	40
3	1KS20EC003	AFEEFA SHARIEFF	29	25	30	10	10	10	10	28.0	38.0	38
4	1KS20EC004	AJAY B G	30	30	30	10	10	10	10	30.0	40.0	40
5	1KS20EC005	AJAY GIRISH	29	30	30	10	10	10	10	29.7	39.7	40
6	1KS20EC006	AKASH M	30	30	30	10	10	10	10	30.0	40.0	40
7	1KS20EC007	ASHRIT MADHAV VADIRAJ	30	28	30	10	10	10	10	29.3	39.3	40
8	1KS20EC008	B.S.HEMASHREE	30	29	30	10	10	10	10	29.7	39.7	40
9	1KS20EC009	BHARATH M	28	29	30	0	10	10	7	29.0	36.0	36
10	1KS20EC010	BHAVITHA B	29	30	27	10	10	10	10	28.7	38.7	39
11	1KS20EC011	BHUVANESHWARI K	29	25	27	10	10	10	10	27.0	37.0	37
12	1KS20EC012	CHAITANYA.K	25	25	30	10	10	10	10	26.7	36.7	37
13	1KS20EC013	CHAITHRA K	28	29	30	10	10	10	10	29.0	39.0	39
14	1KS20EC014	CHALLAGUNDLA SAI SRUJITHA	22	25	30	10	10	10	10	25.7	35.7	36
15	1KS20EC015	CHALLAGUNDLA UMA DEVI	28	30	27	10	10	10	10	28.3	38.3	39
16	1KS20EC016	CHAYA S	28	30	30	10	10	10	10	29.3	39.3	40
17	1KS20EC017	CHETHAN G	28	30	30	10	10	10	10	29.3	39.3	40
18	1KS20EC018	CHETHAN KUMAR J	28	26	30	10	10	10	10	28.0	38.0	38
19	1KS20EC019	CHETHAN KUMAR T	28	29	30	10	10	10	10	29.0	39.0	39
20	1KS20EC020	DARSHAN K	30	28	30	10	10	10	10	29.3	39.3	40
21	1KS20EC021	DARSHAN KUMAR S	30	30	30	10	10	10	10	30.0	40.0	40
22	1KS20EC022	DEEPAK S	30	30	30	10	10	10	10	30.0	40.0	40
23	1KS20EC023	DHAMINI J	30	26	30	10	10	10	10	28.7	38.7	39
24	1KS20EC024	DHRUVA KUMAR S	28	24	30	10	10	10	10	27.3	37.3	38
25	1KS20EC025	DIVYA N	30	29	28	10	10	10	10	29.0	39.0	39
26	1KS20EC026	ESHWAR BIRADAR	28	27	30	10	10	10	10	28.3	38.3	39
27	1KS20EC027	G BHAVANA PRIYADARSHINI	28	28	30	10	10	10	10	28.7	38.7	39
28	1KS20EC028	GAGAN H C	28	30	27	10	10	10	10	28.3	38.3	39
29	1KS20EC029	GAGANA B S	28	30	30	10	10	10	10	29.3	39.3	40
30	1KS20EC030	GANDHAMANI C M	30	30	30	10	10	10	10	30.0	40.0	40
31	1KS20EC031	GOMITHA R C	28	30	30	10	10	10	10	29.3	39.3	40
32	1KS20EC032	HARINI K	28	29	27	10	10	10	10	28.0	38.0	38
33	1KS20EC033	HARSHITH GOWDA A R	28	30	30	10	10	10	10	29.3	39.3	40
34	1KS20EC034	HARSHITHA.B.L	30	30	30	10	10	10	10	30.0	40.0	40
35	1KS20EC035	HARSHITHA.J	30	30	30	10	10	10	10	30.0	40.0	40
36	1KS20EC036	HARSHITHA N	30	30	30	10	10	10	10	30.0	40.0	40
37	1KS20EC037	INCHARA.P	28	30	30	10	10	10	10	29.3	39.3	40
38	1KS20EC038	JAMPULA CHAITHANYA KRISHNA	28	29	27	10	10	10	10	28.0	38.0	38
39	1KS20EC039	JAMUNA S G	28	30	30	10	10	10	10	29.3	39.3	40
40	1KS20EC040	JANHAVI R	28	30	30	10	10	10	10	29.3	39.3	40
41	1KS20EC041	JAYANTH H	28	30	30	10	10	10	10	29.3	39.3	40
42	1KS20EC042	K.JEEVITHA	30	28	30	10	10	10	10	29.3	39.3	40
43	1KS20EC043	K M AMSHUMANTH	30	30	30	10	10	10	10	30.0	40.0	40
44	1KS20EC044	K R SAHANA	30	30	30	10	10	10	10	30.0	40.0	40
45	1KS20EC045	KAVANA.G.S	28	27	30	10	10	10	10	28.3	38.3	39
46	1KS20EC046	KAVYA S M	30	29	30	10	10	10	10	29.7	39.7	40
47	1KS20EC047	KEERTHANA.B.S	28	27	30	10	10	10	10	28.3	38.3	39
48	1KS20EC048	KIRAN DEV D	28	26	30	10	10	10	10	28.0	38.0	38

49	1KS20EC049	KIRAN V NARAYAN	30	30	30	10	10	10	10	30.0	40.0	40
50	1KS20EC050	KODIDELA PRATHIMA	28	30	30	10	10	10	10	29.3	39.3	40
51	1KS20EC051	KUMAR K G	28	30	30	10	10	10	10	29.3	39.3	40
52	1KS20EC052	KUSUMA V R	30	30	30	10	10	10	10	30.0	40.0	40
53	1KS20EC053	M ARCHANA	25	25	30	10	10	10	10	26.7	36.7	37
54	1KS20EC054	MADIHA	30	28	30	10	10	10	10	29.3	39.3	40
55	1KS20EC055	MAHESH BIRADAR	30	30	30	10	10	10	10	30.0	40.0	40
56	1KS20EC056	MANASWINI K M	30	28	30	10	10	10	10	29.3	39.3	40
57	1KS20EC057	MEGHASHREE M	27	30	30	10	10	10	10	29.0	39.0	39
58	1KS20EC058	MOHAN KRISHNA K	30	30	30	10	10	10	10	30.0	40.0	40
59	1KS20EC059	N SHREYA	29	29	30	10	10	10	10	29.3	39.3	40

(Course Incharge)

H.O.D

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE
ARTMENT OF ELECTRONICS AND COMMUNICATION EI

	Course:BASIC ELECTRICAL ENG			sem:II				sec:E			
Sl No	USN No.	Name	IA1	IA2	IA3	A1	A2	A3	Average Assignment	Average of three IA's	Final IA(Assignment+IA)
1	1KS20EC060	NALLANI GOWTHAMI	28	30	30	10	10	10	10	29.3	40
2	1KS20EC061	NEHA C R	30	30	30	10	10	10	10	30.0	40
3	1KS20EC062	NEHA NAGARAJ	30	28	30	10	10	10	10	29.3	40
4	1KS20EC063	P.VASANTH KUMAR	30	30	30	10	10	10	10	30.0	40
6	1KS20EC064	PAVAN.C	30	30	30	10	10	10	10	30.0	40
7	1KS20EC065	PAVANI T S	30	30	30	10	10	10	10	30.0	40
8	1KS20EC066	PRADHYUMNA S KASHYAP	30	30	30	10	10	10	10	30.0	40
9	1KS20EC067	PRAVEEN D B	30	30	30	10	10	10	10	30.0	40
10	1KS20EC068	PREMA G	30	30	30	10	10	10	10	30.0	40
11	1KS20EC069	PRIYANKA.H C	26	30	30	10	10	10	10	28.7	39
12	1KS20EC070	PRIYANKA K	30	30	30	10	10	10	10	30.0	40
13	1KS20EC071	PRIYANKA M	30	30	30	10	10	10	10	30.0	40
14	1KS20EC072	PUSHPA D T	30	30	30	10	10	10	10	30.0	40
15	1KS20EC073	RAHUL KRISHNAN V	30	27	30	10	10	10	10	29.0	39
16	1KS20EC074	RAHUL R	16	27	30	10	10	10	10	24.3	35.0
17	1KS20EC075	RAJATH K ACHAR	30	26	30	10	10	10	10	28.7	39
18	1KS20EC076	RAKSHITH.N.M	28	30	30	10	10	10	10	29.3	40
19	1KS20EC077	RAKSHITH R	30	30	30	10	10	10	10	30.0	40
20	1KS20EC078	RAKSHITHA A	30	27	30	10	10	10	10	29.0	39
21	1KS20EC079	RAMESHWAR	28	30	30	10	10	10	10	29.3	40
22	1KS20EC080	RAMYA T	30	30	30	10	10	10	10	30.0	40
23	1KS20EC081	RAVI VAMSHI.D.N	30	28	30	10	10	10	10	29.3	40
24	1KS20EC082	ROHITH A K	30	27	30	10	10	10	10	29.0	39
25	1KS20EC083	S ARUN KUMAR	30	23	30	10	10	10	10	27.7	38
26	1KS20EC084	SACHIN N M	26	29	26	10	10	10	10	27.0	37
27	1KS20EC085	SADHANA SRINIVAS	30	28	30	10	10	10	10	29.3	40
28	1KS20EC086	SAKSHAM SINGH	30	27	30	10	10	10	10	29.0	39
29	1KS20EC087	SANDEEP Y H	28	28	30	10	10	10	10	28.7	39
30	1KS20EC089	SANJANA G	28	28	30	10	10	10	10	28.7	39
31	1KS20EC090	SANJANA.G	27	26	30	10	10	10	10	27.7	38
32	1KS20EC091	SANJANA T GADIKAR	28	28	27	10	10	10	10	27.7	38
33	1KS20EC092	SHAKTHI ANBAZHAGAN M	30	30	30	10	10	10	10	30.0	40
34	1KS20EC093	SHARATH M	29	28	30	10	10	10	10	29.0	39
35	1KS20EC094	SHASHANK S	28	26	30	10	10	10	10	28.0	38
36	1KS20EC095	SHIVAREDDY B A	30	28	30	10	10	10	10	29.3	40
37	1KS20EC096	SHREYA H	30	28	30	10	10	10	10	29.3	40
38	1KS20EC097	SHREYAS M S	30	26	30	10	10	10	10	28.7	39
39	1KS20EC098	SHREYAS P S RAO	30	28	30	10	10	10	10	29.3	40

40	1KS20EC099	SHWETA DEEPAK K	30	30	30	10	10	10	10	30.0	**40**
41	1KS20EC100	SNEHA A S	30	30	30	10	10	10	10	30.0	**40**
42	1KS20EC101	SONIKA.R	30	30	30	10	10	10	10	30.0	**40**
43	1KS20EC102	SUMANA N	29	30	30	10	10	10	10	29.7	**40**
44	1KS20EC103	SUMUKHA S	30	30	30	10	10	10	10	30.0	**40**
45	1KS20EC104	SURAKSHA N	30	28	30	10	10	10	10	29.3	**40**
46	1KS20EC105	TARUN PRASANNA	30	27	30	10	10	10	10	29.0	**39**
47	1KS20EC106	TEJAS N REDDY	30	27	30	10	10	10	10	29.0	**39**
48	1KS20EC107	THUMMALA GIRISH	28	27	30	10	10	10	10	28.3	**39**
50	1KS20EC108	UDAY C H	30	30	30	10	10	10	10	30.0	**40**
51	1KS20EC109	UJJWAL NAIDU	28	30	30	10	10	10	10	29.3	**40**
52	1KS20EC110	VAISHNAVI A	29	30	30	10	10	10	10	29.7	**40**
53	1KS20EC111	VAISHNAVI V H	30	29	30	10	10	10	10	29.7	**40**
54	1KS20EC112	VARSHA N	30	30	30	10	10	10	10	30.0	**40**
55	1KS20EC113	VIJAYALAKSHMI K	30	26	30	10	10	10	10	28.7	**39**
56	1KS20EC114	VINAY S P	30	30	30	10	10	10	10	30.0	**40**
57	1KS20EC115	VINAY SAGAR V ALUR	24	29	24	10	10	10	10	25.7	**36**
58	1KS20EC116	VINEETH M S	30	30	30	10	10	10	10	30.0	**40**
59	1KS20EC117	YASHILAA S	30	29	30	10	10	10	10	29.7	**40**
60	1KS20EC118	YASHWANTH Y	30	30	30	10	10	10	10	30.0	**40**

Course Incharge

H.O.D.

Visvesvaraya Technological University

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE

Branch : EC Scheme : 2018 Semester : 2

Sl NO.	USN	18CIV24	18EGDL25	18EGH28	18ELE23	18ELEL27	18MAT21	18PHY22	18PHYL26	STUDENT SIGNATURE
1	1KS20EC001	40	38	36	39	36	39	38	40	
2	1KS20EC002	40	40	37	40	39	40	40	40	
3	1KS20EC003	40	39	37	38	38	40	40	40	
4	1KS20EC004	39	40	38	40	37	40	40	40	
5	1KS20EC005	40	40	40	40	40	40	40	40	
6	1KS20EC006	40	40	37	40	39	40	40	40	
7	1KS20EC007	40	40	40	40	40	40	40	40	
8	1KS20EC008	40	40	37	40	37	40	40	40	
9	1KS20EC009	37	40	35	36	32	38	38	40	
10	1KS20EC010	40	40	37	39	38	40	40	40	
11	1KS20EC011	38	40	38	37	37	40	40	40	
12	1KS20EC012	40	39	37	37	37	40	40	40	
13	1KS20EC013	40	39	37	39	37	40	39	40	
14	1KS20EC014	39	39	37	36	35	40	40	40	
15	1KS20EC015	40	38	37	39	36	40	40	40	
16	1KS20EC016	40	40	40	40	40	40	40	40	
17	1KS20EC017	40	40	36	40	36	40	40	40	
18	1KS20EC018	40	38	36	38	35	40	40	40	
19	1KS20EC019	40	39	36	39	37	40	40	40	
20	1KS20EC020	40	38	37	40	38	40	40	40	
21	1KS20EC021	39	40	37	40	39	40	40	40	
22	1KS20EC022	39	40	36	40	38	40	40	40	
23	1KS20EC023	39	40	38	39	37	40	40	40	
24	1KS20EC024	39	38	36	38	36	40	40	40	
25	1KS20EC025	39	40	36	39	39	40	40	40	
26	1KS20EC026	40	40	36	39	38	40	40	40	
27	1KS20EC027	39	39	37	39	39	39	40	40	
28	1KS20EC028	40	38	36	39	35	40	38	40	
29	1KS20EC029	40	40	40	40	40	40	40	40	
30	1KS20EC030	39	39	40	40	40	40	40	40	
31	1KS20EC031	39	39	40	40	38	40	40	40	
32	1KS20EC032	40	38	37	38	36	40	40	40	
33	1KS20EC033	39	40	36	40	38	40	40	40	
34	1KS20EC034	39	40	37	40	38	40	40	40	
35	1KS20EC035	39	40	37	40	38	40	40	40	
36	1KS20EC036	40	40	40	40	40	40	40	40	
37	1KS20EC037	40	38	37	40	36	40	40	40	
38	1KS20EC038	40	38	36	38	37	40	38	40	
39	1KS20EC039	40	40	40	40	40	40	40	40	
40	1KS20EC040	40	39	37	40	38	40	40	40	
41	1KS20EC041	40	40	40	40	40	40	40	40	
42	1KS20EC042	40	40	40	40	40	40	40	40	

SI NO.	USN	18CIV24	18EGDL25	18EGH28	18ELE23	18ELEL27	18MAT21	18PHY22	18PHYL26	STUDENT SIGNATURE
43	1KS20EC043	40	40	40	40	40	40	40	40	
44	1KS20EC044	39	40	37	40	39	40	40	40	
45	1KS20EC045	40	40	37	39	38	39	40	40	
46	1KS20EC046	39	40	37	40	39	40	40	40	
47	1KS20EC047	40	38	37	39	36	40	40	40	
48	1KS20EC048	39	40	38	38	37	40	40	40	
49	1KS20EC049	40	39	38	40	38	40	40	40	
50	1KS20EC050	40	40	37	40	37	40	40	40	
51	1KS20EC051	39	40	37	40	39	40	40	40	
52	1KS20EC052	40	38	36	40	36	40	40	40	
53	1KS20EC053	40	38	36	37	37	38	40	40	
54	1KS20EC054	39	39	36	40	38	40	40	40	
55	1KS20EC055	40	40	40	40	40	40	40	40	
56	1KS20EC056	40	38	36	40	35	40	40	40	
57	1KS20EC057	39	40	37	39	40	40	40	40	
58	1KS20EC058	39	40	37	40	38	40	40	40	
59	1KS20EC059	40	40	40	40	40	40	40	40	
60	1KS20EC060	39	40	37	40	37	40	40	40	
61	1KS20EC061	39	40	37	40	38	39	40	40	
62	1KS20EC062	39	38	37	40	38	40	40	40	
63	1KS20EC063	39	38	37	40	36	40	38	40	
64	1KS20EC064	39	38	37	40	32	38	40	40	
65	1KS20EC065	40	40	40	40	40	40	40	40	
66	1KS20EC066	39	40	38	40	37	40	40	40	
67	1KS20EC067	39	38	37	40	35	40	40	40	
68	1KS20EC068	40	40	40	40	40	40	40	40	
69	1KS20EC069	40	40	40	39	40	40	40	40	
70	1KS20EC070	40	40	37	40	37	38	40	40	
71	1KS20EC071	40	40	36	40	37	40	37	40	
72	1KS20EC072	38	40	37	40	35	38	37	40	
73	1KS20EC073	40	39	40	40	35	40	40	40	
74	1KS20EC074	40	40	37	35	32	39	36	40	
75	1KS20EC075	39	40	38	39	36	40	40	40	
76	1KS20EC076	40	40	38	39	35	39	40	40	
77	1KS20EC077	39	39	37	40	37	40	40	40	
78	1KS20EC078	39	40	37	40	37	39	40	40	
79	1KS20EC079	40	40	36	40	37	40	40	40	
80	1KS20EC080	39	40	37	40	38	40	40	40	
81	1KS20EC081	39	40	38	40	35	40	40	40	
82	1KS20EC082	39	40	37	39	36	40	40	40	
83	1KS20EC083	40	40	36	39	37	40	40	40	
84	1KS20EC084	39	40	36	37	35	38	40	40	
85	1KS20EC085	39	40	37	40	40	39	40	40	
86	1KS20EC086	40	40	40	40	34	40	40	40	
87	1KS20EC087	39	39	36	39	38	40	37	40	
88	1KS20EC089	40	40	37	39	36	40	36	40	
89	1KS20EC090	40	38	37	39	36	37	40	40	
90	1KS20EC091	40	39	37	38	36	40	34	40	
91	1KS20EC092	39	40	37	40	38	40	40	40	
92	1KS20EC093	39	38	37	40	37	40	40	40	

Sl NO.	USN	18CIV24	18EGDL25	18EGH28	18ELE23	18ELEL27	18MAT21	18PHY22	18PHYL26	STUDENT SIGNATURE
93	1KS20EC094	39	40	37	39	38	40	40	40	
94	1KS20EC095	40	40	37	40	37	40	39	40	
95	1KS20EC096	40	40	40	40	40	40	40	40	
96	1KS20EC097	40	39	37	40	35	40	38	40	
97	1KS20EC098	36	39	37	40	34	38	40	40	
98	1KS20EC099	38	39	37	40	38	40	40	40	
99	1KS20EC100	39	40	37	40	38	40	40	40	
100	1KS20EC101	39	40	37	40	37	40	40	40	
101	1KS20EC102	40	40	40	40	40	40	40	40	
102	1KS20EC103	40	40	37	40	37	40	40	40	
103	1KS20EC104	39	40	37	40	39	40	40	40	
104	1KS20EC105	40	40	40	40	40	40	40	40	
105	1KS20EC106	40	39	37	39	35	40	36	40	
106	1KS20EC107	40	40	36	39	36	40	40	40	
107	1KS20EC108	40	40	40	40	40	40	40	40	
108	1KS20EC109	40	40	35	40	38	39	40	40	
109	1KS20EC110	40	40	40	40	40	40	40	40	
110	1KS20EC111	39	40	37	40	37	40	40	40	
111	1KS20EC112	39	40	36	40	38	40	40	40	
112	1KS20EC113	40	39	37	39	38	40	40	40	
113	1KS20EC114	40	39	37	40	37	40	40	40	
114	1KS20EC115	40	39	38	36	34	40	39	40	
115	1KS20EC116	39	40	38	40	37	40	40	40	
116	1KS20EC117	40	40	40	40	40	40	40	40	
117	1KS20EC118	40	40	37	40	36	38	40	40	
--x--	Faculty Signature									----xxxxxxx----

* - values are either optional subjects or the faculty has not yet entered the marks

5/10/21

HOD
Seal and Signature
HEAD OF THE DEPARTMENT
Dept. of Electronics & Communication Engg
K.S. Institute of Technology
Bengaluru - 560 109

PRINCIPAL
Seal and Signature
PRINCIPAL
K.S. INSTITUTE OF TECHNOLOGY
BENGALURU - 560 109.

Challenging questions for toppers on MODULE-1

Subject: Basic Electrical Engineering
Subject code: 18ELE13

1. Two batteries having emfs of 10v and 7v and internal resistances of 2ohm and 3ohm respectively are connected in parallel across a load of resistance 1ohm. Calculate (i) the current supplied by each battery (ii) the current through the load and (iii) the voltage across the load

2. Twelve 1 ohm resistances are used as edges to form a cube. What is the resistance between two diagonally opposite corners of the cube?

3. What are the requirements for the waveform to be classified as periodic?

4. A square wave has equal positive and negative peak values what are its average and effective values.

Reference:

2. Basic electrical engineering by \D C Kulshreshtha

Challenging questions for toppers on MODULE-2

Subject: Basic Electrical Engineering
Subject code: 18ELE13

1. For a series AC Circuit having resistive and reactive component.
   a) How do u determine active power consumed. Give two equations for calculating the active power
   b) What does volt ampere mean?
   c) What does volt ampere reactive mean?
   d) How is the VAR calculated?

2. In an AC circuit if $V=100\angle 60^{\circ}$ V and $I= V=10\angle 30^{\circ}$ A, will the power going to circuit be 1000W?

3. Discuss the effect of variation of power factor on wattmeter readings in a two wattmeter method of measuring power of a 3 phase circuit.

4. Explain why an unbalanced star connected load is not normally used on a 3wire, 3 phase system.

Reference:

1. Basic electrical engineering by D C Kulshreshtha

CHALLENGING QUESTIONS IN BASIC ELECTRICAL ENGG.

1. If R1 has a resistance of 2.0 ohm and R2 receives energy at the rate of 5.5W, what is (are) the value(s) for the circuit's current (s)? (There may be more than one answer.) Express your answer using two significant figures. If there is more than one answer, enter them in ascending order separated by commas.

2. A silver wire is 6.1 m6.1 m long and 0.71 mm0.71 mm in diameter. What is its resistance?

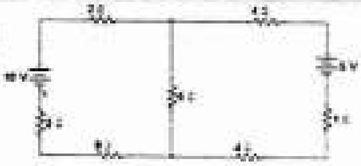
3. The wiring in a house must be thick enough so it does not become so hot as to start a fire. What diameter must a copper wire be if it is to carry a maximum current of 31 A31 A and produce no more than 1.4 W1.4 W of heat per meter of length?

4.Two wires have the same diameter, but one is made of copper and the other of aluminum. The copper wire is 2.04 m long and its resistance is 1.91 times that of the aluminum wire. How long is the aluminum wire?

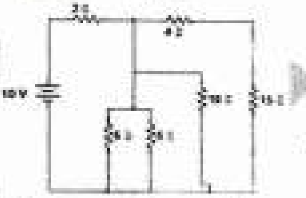
5. A wire is cut in half and twisted into a single wire. How does this change its resistance?

6.If two electric fences have the same voltage, how can one fence give off more of a shock then the other? Explain what must be different about the electrical settings of the circuit.

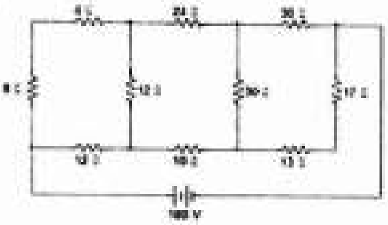
7. When switch S in the figure is open, the voltmeter V of the battery reads 3.11V3.11V. When the switch is closed, the voltmeter reading drops to 2.96V2.96V, and the ammeter A reads 1.64A1.64A. Assume the two meters are ideal, so they don't affect the circuit. Find the circuit resistance R.



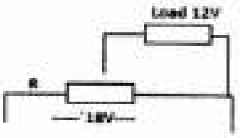
4. **Find using KCL, the current through the 6Ω resistor of the circuit shown.**
(Soln : 0.641A flowing from A to B)



5. **Find current through 10Ω resistor in the given circuit, use nodal analysis.**



6. **Determine the current in 10Ω resistor in the network shown , use star-delta conversion.**



7. **For the 100Ω potentiometer shown, find the resistance R for a load current of 10A.**

Three Phase Circuit

i) In a three phase system, if the instantaneous values of phase R and Y an +60V and -40V respectively then the voltage of phase B if

A) -20V   B) 40V   C) 120V   D) None of these

ii) The power consumed in the 3ϕ, 400V star connected load of RΩ/ph is 690W. The line current is

A) 2.5 A   B) 1A   C) 1.725 A   D) None of these

iii) In a 3ϕ circuit, if load power factor is decreased, then the line current

A) decreases   B) increases   C) remains the same   D) None of these

iv) In a balanced star connected system, the angle difference between line voltages and phase voltages are

A) 30°   B) 60°   C) 120°   D) in phase

i) When power factor is 0.5, the wattmeter reading is such that

A) $w_1 = w_2$ B) w_1 is +ve, w_2 is –ve   C) w_1 is +ve, $w_2 = 0$ D) $w_1 = 2\ w_2$.

ii) The relation between line and phase quantities in a delta connection is

A) $E_\ell = \sqrt{3}\ E_{ph}, I_\ell = I_{ph}$ B) $E_\ell = E_{ph}, I_\ell = \sqrt{3}\ I_{ph}$

C) $E_\ell = \sqrt{3}\ E_{ph}, I_\ell = \sqrt{3}\ I_{ph}$ D) $E_\ell = E_{ph}, I_\ell = I_{ph}$.

iii) The angle between line voltage and phase voltage for a balanced star connected circuit is

A) 30°   B) 30° ± ϕ   C) 60°   D) 120°.

iv) In a 3ϕ system, if the instantaneous value of phase R and Y are +60V and –40V respectively, then instantaneous voltage of phase B is

A) – 20 V   B) 40 V   C) 120 V   D) none of the above. **(04 Marks)**

i) The total power consumed by a 3 phase balanced load is given by

A) $W_1 - W_2$ B) $\frac{W_1 + W_2}{2}$ C) $\sqrt{3}(W_1 - W_2)$ D) None of these

where W_1 and W_2 are wattmeter readings

ii) Electrical displacement between different phases in a six phase system is

A) 60°   B) 120°   C) 240°   D) None of these

iii) The frequencies of 3 phase voltage in a three phase balanced system are

A) Different   B) Same   C) Zero   D) Infinity

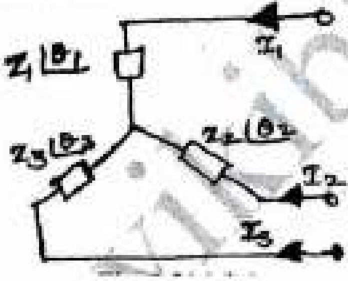
iv) Fig.Q.3(a)(iv) represents

A) Unbalanced star convected supply.

B) Balanced star connected load.

C) Balanced star connected supply.

D) Unbalanced star connected load.



[illegible]

i) The sum of the two-wattmeters readings in a 3 phase balanced system is

A) $V_{ph} I_{ph} \text{Cos}\phi$ B) $3 V_L I_L \text{Cos}\phi$ C) $\sqrt{3} V_L I_L \text{Cos}\phi$ D) None of these.

ii) The rated voltage of a 3 phase system is given as

A) rms phase voltage B) peak phase voltage

C) rms line-to-line voltage D) peak line-to-line voltage

iii) A 3 phase star connected load consumes P watts of power from a 400V supply. If the same balanced load is connected in delta across that same supply, then power consumption is

A) 3 P B) $\sqrt{3}$ P C) $\frac{P}{3}$ D) P

iv) The phase sequence RBY denotes that

A) emf of phase-B lags that of phase-R by 120°

B) emf of phase-B leads that of phase-R by 120°

C) Both (A) and (B) are correct

[illegible]

i) The algebric sum of instantaneous phase currents on a three phase balanced system is

A) one B) zero

C) infinity D) none of these

ii) In star connected system, the relation between the line voltage and phase voltage is

A) $El = Eph$ B) $Eph = \sqrt{3}\, El$

C) $El = \sqrt{3}\ Eph$ D) $El = 3\ Eph$

iii) In the two-wattmeter method of measuring 3-phase power, one of the wattmeter reads zero, when the load angle power factor angle is

A) 60° B) 0°

C) 90° D) 30°

iv) The expression of 3.ϕ power equation in terms of phase values

A) $3\ V_{ph} I_{ph} \text{Sin}\ \phi$ B) $\sqrt{3}\ V_{ph} I_{ph} \text{Cos}\ \phi$

C) $3\ V_{ph} I_{ph} \text{Cos}\ \phi$ D) $\sqrt{3}\ V_{ph} I_{ph} \text{Sin}\ \phi$

i) Three inductive coils each having an impedance of 17.7 Ω are connected in star. The circuit is fed from a 3-phase, 400 V, 50 Hz supply. The current (line) drawn by the circuit is equal to

A) 22.6 A B) 39.14 A C) 13 A D) none of these

ii) For a 3-phase star connected balanced circuit having inductive load, the angle between the line currents and corresponding line voltages is equal to

A) 30° B) $30° - \phi$ C) $30° + \phi$ D) ϕ

iii) When two wattmeters are connected in a 3-phase circuit to measure its total power consumption, one of the wattmeter would read zero, when the load power factor is.

A) 0.2 lagging B) unity C) 0.5 lagging D) zero

iv) Active power drawn by a 3-phase balanced load is given by

A) $P = V_L I_L \cos\ \phi$ B) $P = \sqrt{3}\, V_L I_L$

C) $P = \sqrt{3}\, V_L I_L \cos\ \phi$ D) $P = \sqrt{3}\, V_{ph} I_{ph} \cos\ \phi$ (04 Marks)

Three Phase Synchronous Generator

i) A 4 pole, 1200 rpm alternator generates emf at a frequency of
A) 25 Hz B) 40 Hz C) 50 Hz D) 60 Hz

ii) The field winding of an alternator is excited by
A) dc B) ac C) ac & dc D) 3 ph. ac

iii) A salient pole field construction is used for alternator having
A) low & medium speed B) large speed C) very large speed D) none of these

iv) The values of pitch factor (k_P) for full pitch
A) less than 1 B) more than 1 C) 1 D) 0

i) The stater of an alternator is identical to that of a
A) DC generator B) three phase induction motor
C) single phase induction motor D) none of these.

ii) The field winding of an alternator is ______ excited.
A) DC B) AC C) Both DC and AC D) none of these

iii) High speed alternators are driven by
A) diesel engine B) hydraulic turbines C) steam turbines D) none of these.

iv) The disadvantages of a short pitched coils in an alternator is that
A) harmonics are introduced B) waveform become non sinusoidal
C) voltage round the coil is reduced D) none of the above. **(04 Marks)**

i) The frequency of voltage generated by an alternator having 8-poles and rotating at 250 rpm is
A) 60 Hz B) 50 Hz C) 25 Hz D) $16\frac{2}{3}$ Hz

iii) An alternator has a phase sequence of RYB for its phase voltage. In case the direction of rotation of alternator is reversed, the phase sequence will become
A) RBY B) RYB
C) YRB D) none of these

iv) Alternators have short-pitched winding so as to
A) increase machine rating B) improve the voltage waveform
C) improve generated voltage D) none of these **(04 Marks)**

i) A 4 pole, 1200 rpm alternator generates emf at a frequency of
A) 25 Hz B) 40 Hz C) 50 Hz D) 60 Hz

ii) The field winding of an alternator is excited by
A) dc B) ac C) ac & dc D) 3 ph. ac

iii) A salient pole field construction is used for alternator having
A) low & medium speed B) large speed C) very large speed D) none of these

iv) The values of pitch factor (k_P) for full pitch
A) less than 1 B) more than 1 C) 1 D) 0

i) In synchronous generators

A) the field poles are stationary and the armature conductors rotate
B) the armature conductors are stationary and the field poles rotate
C) field and armature both are stationary
D) none of these

ii) A 4-pole, 1200 rpm alternater will generate an emf at a frequency of

A) 60 Hz B) 50 Hz C) 40 Hz D) 25 Hz

iii) Full pitch windings have coil span of

A) 180° B) 90° C) 270° D) 360°

iv) The current from an alternator is taken out to external load circuit through

A) commutator segments B) slip-rings
C) carbon brushes D) solid connection

By means of a neat diagram, describe the main parts of an alternator with their functions.

Three Phase Induction Motor

i) The clip of an induction motor at standstill is

A) 0 B) 1 C) ∞ D) − 1

ii) Synchronous speed of three ph. Induction motor is given by

A) $N_s = 120\ fP$ B) $120f/P$ C) $120\ P/f$ D) $fP\ /\ 120$

iii) A 4 pole, 440 V, 50 Hz induction motor is running at a slip of 4% the speed of motor is

A) 1260 rpm B) 1440 rpm C) 1500 rpm D) 1560 rpm

iv) Speed of an induction motor is _______ that of N_s

A) greater than B) less than C) same as D) double

i) The difference between synchronous speed and actual speed is 100 rpm and the synchronous speed is 1500 rpm, then the value of slip is

A) 2% B) 10% C) 6.66% D) 15%.

ii) External resistance is connected to the rotor of a 3ϕ phase wound induction motor in order to

A) reduce starting current B) collector current
C) as a star connected load D) none of these.

iii) When the rotor of a 3ϕ induction motor is blocked, the slip is

A) zero B) 0.5 C) 0.1 D) L

iv) Phase wound induction motors are less extensively used than squirrel cage induction motors because,

A) slip rings are required on the rotor circuit
B) rotor windings are generally star connected
C) they are costly and require greater maintenance
D) none of the above.

(04 Marks)

Single Phase Transformer

i) The core of a transformer is assembled with laminated sheets so as to
   A) reduce hysteresis loss
   B) reduce Eddy current loss
   C) both hysterisis and Eddy current loss
   D) copper loss

ii) A single phase, 5 kVA, 200 V/100 V, transformer has rated primary and secondary currents at rated voltage
   A) 25 A and 50 A   B) 50 A and 25 A
   C) 12.5 A and 62.5 A   D) 62.5 A and 12.5 A

iii) If the fuel load core loss of a transformer is 100 W, its core loss at half load will be
   A) 200 W   B) 100 W   C) 50 W   D) 25 W

iv) A transformer operates at maximum efficiency, when
   A) core losses minimum
   B) copper loss minimum
   C) core loss = copper loss

(04 Marks)

[illegible]

i) The eddy current loss in a transformer is minimized by using
   A) solid core   B) laminated core   C) plastic core   D) none of these

ii) If an ammeter in the secondary of a 100V/10V transformer reads 10A, the current in the primary would be
   A) 1A   B) 2A   C) 10A   D) 100A

iii) Efficiency of a transformer is maximum when
   A) copper loss = $\sqrt{\text{core loss}}$ B) core loss = $\sqrt{\text{copper loss}}$
   C) copper loss = core loss   D) none of these

iv) Losses which do not occur in a transformer is
   A) copper losses   B) magnetic losses   C) friction losses   D) none of these.

Explain briefly the principle of operation of a transformer and show that the voltage ratio of primary and secondary windings is the same as their turns ratio. (04 Marks)

i) A transformer transfers electrical energy from primary to secondary usually with a change in
   A) frequency   B) power   C) voltage   D) time period.

ii) when the supply frequency of a transformer is doubled then the hystersis losses
   A) remain same   B) doubled
   C) reduced by 50%   D) hystersis loss equal to eddy current loss.

iii) Regulation and efficiency of a transformer should be respectively
   A) high, high   B) high, low
   C) low, high   D) low, low

iv) The full load copper loss for a transformer is 800 W, then the copper loss at half the full load is
   A) 400 W   B) 800 W   C) 200 W   D) 1600 W   (04 Marks)

(04 Marks)

i) The magnitude of mutual flux in a transformer is
   A) low at low loads and high at high loads
   B) high at low loads and low at high loads
   C) same at all loads
   D) varies at low loads and constant at high loads.

ii) Transformer cores are laminated in order to
   A) Simplify its construction   B) minimize eddy current loss
   C) reduce cost   D) reduce hysteresis loss

iii) The transformation ratio of a transformer is
   A) V_1/V_2 B) N_2/N_1 C) I_2/I_1 D) All of these

iv) A transformer is working at its maximum efficiency with iron-loss of 500W, then its copper-loss will be
   A) 500 W   B) 250 W   C) 300 W   D) 400 W

i) The copper loss of certain transformer at half full load is 200 W. Then the full load copper loss is
   A) 100 W   B) 200 W   C) 400 W   D) 800 W

ii) If secondary current of 100/10 V transformer is 10 A, then primary current is
   A) 1 A   B) 2 A   C) 10 A   D) 100 A

iii) The core of a transformer is laminated to reduce
   A) eddy current   B) hysteresis current   C) copper loss   D) friction loss

iv) The frequency loss of secondary voltage is ______ that of primary voltage.
   A) greater than   B) less than   C) same as   D) double

Reg. No. :

Question Paper Code : 71645

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Second Semester

Civil Engineering

GE 2151/EE 26/EE 1153/080280011/10133 EE 206 — BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

(Common to Aeronautical, Automobile, Marine, Mechanical, Production, Chemical, Petroleum Engineering, Biotechnology, Polymer, Textile, Textile (Fashion), Plastic Technology, Environmental Engineering, Geoinformatics Engineering, Industrial Engineering, Industrial Engineering and Management, Manufacturing Engineering, Material Science and Engineering, Mechanical and Automation Engineering, Mechatronics Engineering, Petrochemical Engineering, Chemical and Electrochemical Engineering, Petrochemical Technology, Pharmaceutical Technology and Textile Chemistry)

(Regulation 2008/2010)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define R.M.S. value of an alternating quantity.

2. Name the essential torques required for the proper operation of indicating instrument.

3. An 8 pole, lap wound armature rotated at 350 rpm is required to generate 260 V. The useful flux/pole is 0.05 Wb. If the armature has 120 slots, calculate the number of conductors per slot.

4. What is the significance of back emf?

5. Compare PN junction diode and Zener diode.

6. What is effect of saturation of a transistor?

7. Convert $7FS_H$ into decimal.

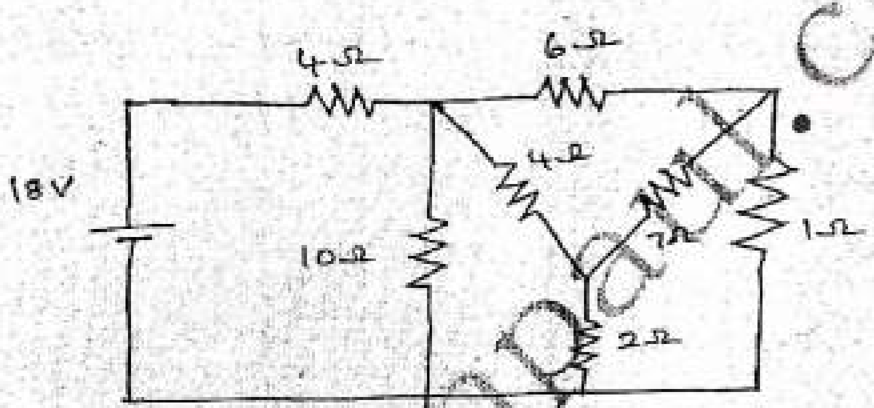
8. What is a flip flop?

9. Differentiate analog and digital signals.

10. Define Total internal reflection.

PART B — (5 × 16 = 80 marks)

11. (a) Describe Kirchoff's laws. For the circuit shown in the figure below, determine the current through 6 Ω resistor.



Or

(b) (i) With the help of diagrams, explain the construction and working principle of permanent magnet moving coil instruments. Obtain an expression for its deflecting torque.

(ii) Explain the working principle of dynamometer type of wattmeter. Mention its disadvantages also.

12. (a) A 220-V D.C. series motor runs at 700 rpm when operating at its full-load current of 20 A. The motor resistance is 0.5 Ω and the magnetic circuit may be assumed unsaturated. What will be the speed if:

(i) Load torque is increased by 44%?

(ii) Motor current is 10 A?

(iii) Explain the operation and principle of a DC motor.

Or

(b) Explain the construction of single phase transformer.

13. (a) (i) Explain the operation of Full wave rectifier.

(ii) Derive the expression for RMS voltage, current, DC power, efficiency, PIV and TUF.

Or

(b) Explain the elementary treatment of small signal amplifier.

14. (a) (i) Realize and draw the logic diagram for the given function with minimum number of gates $\overline{A}B + ABC + A\overline{B}(B+C) + AB\overline{C}$.

(ii) Explain the operation and truth table of half adder with a neat diagram.

Or

(b) (i) Draw and explain operation of JK flip flop.

(ii) Describe the categorization and functioning of shift registers.

15. (a) Why modulation is necessary? Write in detail about frequency modulation.

Or

(b) Discuss the usage of satellite for long distance communication with a neat block diagram of basic satellite transponder.

S - 1487

Total No. of Pages : 3

Seat No.	

F.E. (All) (Semester - I&II) (Revised) Examination, May - 2015
BASIC ELECTRICAL ENGINEERING
Sub. Code : 59178

Day and Date : Wednesday, 13 - 05 - 2015 **Total Marks : 100**

Time : 10.00 a.m. to 01.00 p.m.

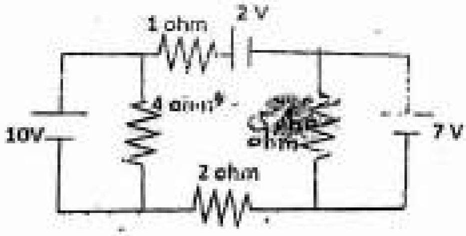
Instructions:
1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Draw neat labeled diagrams as a part of explanation.
4) In case of missing data, assume suitable value. State it clearly.

SECTION -I

Q1) Answer any two. *[2 × 9 = 18]*

a) Explain the following terms and state their practical importance: Magnetic saturation, Magnetic leakage, Magnetic fringing.

b) Find the current in 2 ohm resistance in the following circuit. Comment on the battery currents.



c) Find the efficiency of a motor-centrifugal pump set that completely fills a 1000 ,litre tank by lifting water through 80 m in exactly 45 minutes while d.c. motor in the set draws 3A from 200V d.c supply. The electric bill for this work is Rs. 4. Find the rate of electric energy supply in Rs/KWh.

Q2) Answer any two. *[2 × 9 = 18]*

a) If a current 'Im sin wt' flows in a series R-L circuit, derive the expression for voltage across the combination, impedance and phase difference between voltage and current. Draw the phasors for all voltages and current.

b) State the advantages of high power factor, Eplain the pf improvement using a static capacitor. Draw the appropriate phasor diagrams.

c) A coil is connected in series with a 100 microF condenser and 200V, 50 Hz sinusoidal ac is applied to the circuit. The circuit draws 5A at unity pf. Find the impedance and pf of the coil.

Q3) Answer any two. *[2 × 7 = 14]*

a) With a neat diagram, list the elements necessary in equipment earthing. Explain the electric shock prevention to the user in case of insulation failure fault.

b) Explain the operating principle of LED. Hence list the advantages of LED lamp over CFL.

c) Explain the role of conventional choke and glow type starter in a fluorescent tube.

SECTION - II

Q4) Answer any two. *[2 × 9 = 18]*

a) Define and explain: Symmetrical 3 phase ac supply, phase sequence, 3 phase balanced load.

b) Compare the star connected 3 phase load with delta connected 3 phase load in terms of phase voltage, phase current power drawn, other advantages related to the configuration. (Assume same line voltage.)

c) List the advantages of 3 phase power generation, transmission, distribution and 3 phase machines.

Q5) Answer any two. *[2 × 9 = 18]*

a) Explain the construction of the core and the windings in a core type transformer and a shell type transformer. State the measures taken to reduce the flux leakage.

b) Explain the operating principle of single phase alternator. State the advantages of rotating field structure over rotating armature structure.

c) A 220V/110V, 1.1KVA single phase transformer draws 80W at no load. Then a 0.8 lagging pf load is connected and gradually increased upto full load. The full load copper loss is 100W.

i) Find the transformer efficiency at one fourth of the full load.

i) Find the amount of load for operating this transformer at maximum efficiency

(Assume zero voltage regulation throughout.)

Q6) Answer any two. [2 × 7 = 14]

a) Draw the circuit, explain the working of a capacitor run type single phase Induction motor and state its advantages

b) State the dissimilarities between a split phase induction motor and a Shaded pole induction motor with respect to the stator structure, torgue, reversiblilty, appliations.

c) State the important features of an universal motor. Explain why the torque does not reverse when the AC supply current reverses

❖❖❖❖

Question Paper Code : 80128

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fourth Semester

Biomedical Engineering

BM 6402 — BASICS OF ELECTRICAL ENGINEERING

(Regulations 2013)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Define Reluctance.

2. How will you reduce eddy current loss?

3. Under what condition the efficiency of a transformer is maximum?

4. Distinguish between core type and shell type transformer.

5. Draw the speed-torque characteristics of DC shunt and series motor.

6. List the applications of stepper motors.

7. Name different types of three phase induction motor.

8. Write the EMF equation of an alternator.

9. Why single phase induction motor is not self starting?

10. State the function of capacitor in a single phase induction motor.

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) Draw a B-H curve for a ferromagnetic material and explain why this curve is non linear? Explain the term saturation. (8)

(ii) In an iron specimen hysteresis loss is 300W when B_{max} is 0.9 T at frequency is 50 Hz. What would be the loss if B_{max} is increased to 1.1 T and frequency is decreased to 40 Hz. Assume that loss is proportional to $(B_{max})^{1.7}$. (8)

Or

(b) (i) State and explain Faraday's law of electromagnetic induction. (8)

(ii) An Aeroplane having a wing span of 52 m is flying horizontally at 1100 KM/Hr. If the vertical component of earth's magnetic field is 38×10^{-6} T. Find the emf generated between the wing tips. (8)

12. (a) (i) Derive the emf equation of a transformer. (8)

(ii) The primary winding of a 50 Hz transformer has 480 turns and is fed from 6400 V supply.

Find :

(1) The peak value of the flux in the core.

(2) Secondary voltage if the secondary winding has 20 turns. (8)

Or

(b) (i) Derive an expression for the saving of copper in an Auto transformers. (8)

(ii) Define regulation of a transformer. Derive the condition for zero regulation. (8)

13. (a) Describe various methods of speed control of DC shunt motor.

Or

(b) Describe the various characteristics of DC generators and give their applications.

14. (a) Explain double field revolving theory with neat sketches.

Or

(b) Explain any two methods of starting of synchronous motors.

15. (a) Describe the construction features and principle of operation of repulsion motor.

Or

(b) With a neat diagram explain the working principle of AC series motor.

B.E./B. Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fourth Semester

Biomedical Engineering

BM 6402 – BASICS OF ELECTRICAL ENGINEERING

(Regulations 2013)

Time : Three Hours

Maximum : 100 Ma

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Define magnetic flux density and write its unit.
2. Write Lorentz force equation.
3. Name the types of transformer based on construction.
4. Define all day efficiency of a transformer.
5. What are the functions of commutator and brushes in a dc machine ?
6. List the applications of dc shunt and series motors.
7. What do you mean by synchronous speed of an induction motor and write th expression.
8. Plot the V-curves of synchronous motors for various loads.
9. What are the types of single-phase induction motors ?
10. Why commutator motors are called so ?

PART – B (5 × 16 = 80 Marks)

11. (a) Explain the various types of magnetic materials and their properties. (16)

OR

(b) (i) The magnetic circuit has the following dimensions.

$A_C = 4 \times 4$ cm², lg = 0.06 cm, lc = 40 cm,

N = 600 turns, μr = 6000 for iron, λ = (1.152 sin 314 t) wb – T.

Find induced emf (e), Reluctance (Rc and Rg), coil inductance (L), Stored energy (W). Neglect the effect of fringing. (10)

(ii) What are hysteresis and eddy current losses ? Explain. (6)

12. (a) (i) Derive the emf equation of a transformer. (8)

(ii) Explain the operation of transformer under no-load with phasor diagram. (8)

OR

(b) (i) Explain briefly about auto-transformers. (8)

(ii) On a 25 kVA, 1000/200 V transformer, the iron and copper losses are 350 and 400 watts respectively. Calculate the efficiency on unity power factor at full load and half load. (8)

13. (a) (i) Explain the operation of dc generator with neat diagrams. (10)

(ii) A 4-pole dc shunt generator with lap-connected armature supplies a load of 100 A at 200 V. The armature resistance is 0.1 Ω and the shunt field resistance is 80 Ω. Find the total armature current and the emf generated. Assume a brush contact drop of 2V. (6)

OR

(b) Describe the various methods of speed control of dc motors with relevant diagrams. (16)

14. (a) Describe the construction of an induction motor with neat diagrams. (16)

OR

(b) (i) A 3-phase 10-pole star connected alternator runs at 600 rpm. It has 120 stator slots with [illegible] conductors per slot and the conductors of each phase are all connected in series. Find the line and phase emfs, if the flux per pole is 56 mwb. Assume full pitch coil with distribution factor as 0.955. (6)

(ii) Briefly explain the various methods of starting the synchronous motors. (10)

15. (a) Explain about split-phase resistance start and capacitor start types of single-phase induction motors. (16)

OR

(b) Describe the construction and working of AC series motor with neat diagram and characteristic curves. (16)

121

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fourth Semester

Biomedical Engineering

BM 6402 – BASIC OF ELECTRICAL ENGINEERING

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define ampere circuit law.
2. Draw the Hysteresis loss curve.
3. Draw the equivalent circuit of transformer.
4. Define all day efficiency.
5. Write notes on types of DC motor.
6. List the applications of stepper motor.
7. Write the Torque equation of Synchronous motor.
8. List the types of three phase induction motor.
9. How AC series motor is classified based on winding, draw the circuit of it.
10. List the various types of single phase induction motor.

PART B — (5 × 13 = 65 marks)

11\. (a) List the factors affecting self-inductance of the coil.

Or

(b) Write notes on magnetic equivalent circuit.

12. (a) Derive the E.M.F equation for the transformer.

Or

(b) Enumerate various losses in transformer. How these losses can be minimized?

13. (a) Explain the construction of DC generator with neat diagram.

Or

(b) A 500V DC shunt motor draws a line current of 5A on light load. If armature resistance is 0.15 ohm and field resistance is 200 ohms, determine the efficiency of the machine running as a generator delivering load current of 40 Amps.

14. (a) Explain the construction of three phase induction motor with neat diagram.

Or

(b) Derive the E.M.F equation for the alternator.

15. (a) Explain the types of single phase induction motor with neat diagram.

Or

(b) Explain the construction of repulsion motor with neat diagram.

PART C — (1 × 15 = 15 marks)

16. (a) The core of a three phase, 50Hz, 11000/550 V delta/star, 300kVA, core type transformer operates with a flux of 0.05 b find

(i) number of H.V and L.V turns per phase

(ii) E.M.F per turn

(iii) full load H.V and L.V phase currents

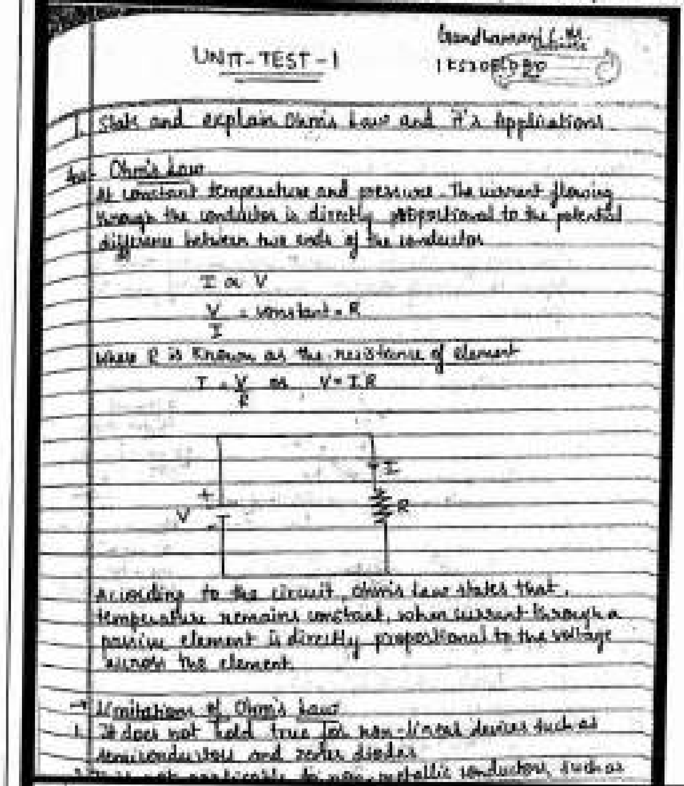
Or

(b) A separately excited DC generator has armature circuit resistance of 0.1 Ω and the total brush (b) drop is 2V. When running in 1000 rpm it delivers a current of 100 A at 250V to a load of constant resistance. If the generator speed drop to 700 rpm with field current unaltered, find the current delivered to load. With what load resistance will the current be 100A at 700 rpm.

K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109
DEARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
TEACHING AND LEARNING
PEDAGOGY REPORT

Academic Year	2020-21 (Even)
Name of the Faculty	VISHALINI DIVAKAR
Course Name /Code	Basic Electrical Engg. /18ELE23
Semester/Section	II/D & E
Activity Name	UNIT TEST
Topic Covered	MODULE-1- DC CIRCUITS
Date	11/6/21
No. of Participants	
Objectives/Goals	• To check the level of subject knowledge of the students • To help the students to prepare for scoring well in internals and exam.
ICT Used	Laptops and Wi-Fi
Appropriate Method/Instructional materials/Exam Questions Questions were asked from previous exam papers so that it will help the students to be aware of the exam questions.	
Relevant PO's	1,2,3
Significance of Results/Outcomes	• I got to know the understanding level of the students. • Students came to know how to study and how to write the exams for scoring well in this course.
Reflective Critique	It was very useful for the students to get the awareness of examination questions.

Proofs (Photographs/Videos/Reports/Charts/Models)



UNIT-TEST-1

Gandhamani C.M.
1KS20EC080

I. State and explain Ohm's Law and it's Applications

Ans. Ohm's Law
At constant temperature and pressure. The current flowing through the conductor is directly proportional to the potential difference between two ends of the conductor

$I \propto V$

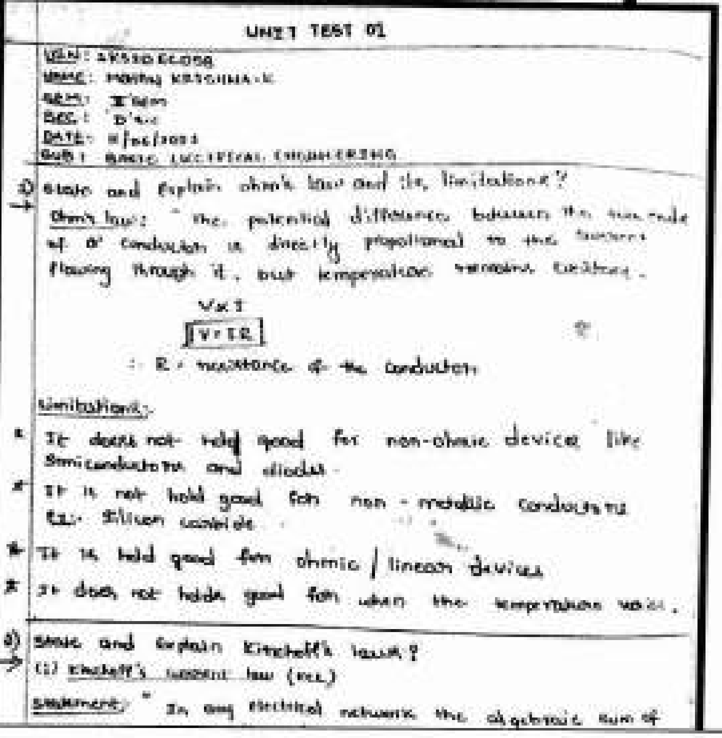
$\frac{V}{I}$ = constant = R

Where R is Known as the resistance of element

$I = \frac{V}{R}$ or, $V = IR$

According to the circuit, ohm's law states that, temperature remains constant, when current through a passive element is directly proportional to the voltage across the element.

→ Limitations of Ohm's Law
1. It does not hold true for non-linear devices such as semiconductors and zener diodes
2. It is not applicable for non-metallic conductors, such as



UNIT TEST 01

USN: 1KS20EC058
NAME: MOHAN KRISHNA.K
SEM: II Sem
SEC: 'D' sec
DATE: [illegible]
SUB: BASIC ELECTRICAL ENGINEERING

1) State and Explain ohm's law and its limitations?
→ Ohm's law: "The potential difference between the two ends of a conductor is directly proportional to the current flowing through it, but temperature remains constant.

$V \propto I$

$\boxed{V = IR}$

∴ R = resistance of the conductor

Limitations:-
- It does not hold good for non-ohmic device like semiconductors and diodes.
- It is not hold good for non-metallic conductors Ex:- Silicon carbide
- It is hold good for ohmic / linear devices
- It does not holds good for when the temperature varies.

2) State and Explain Kirchoff's laws?
→ (1) Kirchoff's current law (KCL)
Statement: " In any electrical network the algebraic sum of

Signature of Course In charge

Signature of HOD ECE

Content beyond syllabus
Basic Electrical Engineering

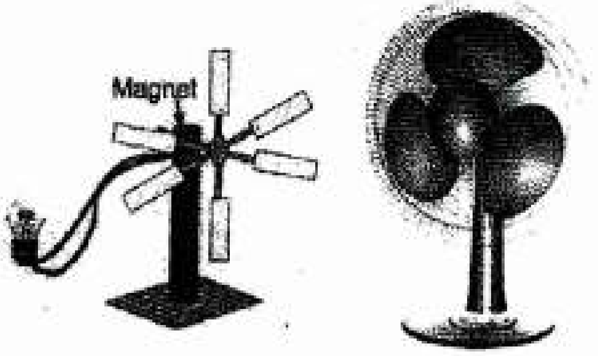
Object -To build a model windmill generator to power a light bulb

Global warming is a hot topic today, literally! Global warming is increasing the temperature of the Earth and causing all sorts of natural disasters like hurricanes, droughts and floods. Excess carbon dioxide causes global warming and is produced from burning fossil fuels to make energy, like coal and oil. One solution to this problem is to use a renewable energy source, like wind, that doesn't create carbon dioxide.

Wind in the atmosphere pushes the blades of the windmill, which rotate a turbine inside the structure. The turbine spins large coils of wire around a magnet, which creates the electricity we use in our house.

Materials

- One 3-inch nail
- Paper towel tube
- 26 wooden popsicle sticks
- Craft glue
- Hot glue
- One wooden craft circle, about 3 inches in diameter
- 6 pieces of card stock, 5 inches long by 2 inches wide
- Small household fan
- One neodymium magnet that will fit inside the paper towel tube
- Masking tape
- At least 3 feet of 30-gauge copper magnet wire
- A 1.5 volt light bulb
- Scissors



Steps

1. Start by creating your base. Glue 10 popsicle sticks side by side. Glue an additional 10 sticks on top of that layer in the opposite direction. Allow about 30 minutes to dry.

<u>Safety Tip!!</u> Hot glue can burn you. Be careful and avoid getting it on your hands.

2. While your base is drying, use the hot glue to attach the craft circle to the head of the nail.

3. Next, hot glue six popsicle sticks to the craft circle to make the blades of the windmill.

4. Use the craft glue to attach the card stock to finish forming each blade.

5. Next, puncture the nail through both sides of the paper towel tube about 1 inch from the top. Spin the nail to make sure it moves freely through the tube.

6. Hot glue the paper towel tube to the base with the nail at the top once the base is dry.

<u>Safety Tip!!</u> Neodymium magnets are very strong, don't place them near any electronics!

7. Next, glue the magnet to the nail inside the paper towel tube.

8. Next, coil the magnet wire around the outside of the paper towel tube around the area containing the magnet. Leave about 5 inches on either side of the wire to attach to the light bulb.

9. Tape the wires to the paper towel tube to keep them in place.

10. Now, make sure the wire is exposed under the plastic. You may need to use scissors to cut back some of the plastic. Then, coil the wires around the base of the light bulb, making sure they are connected tightly.

11. It's time to test your turbine. Turn on the fan to spin the blades and watch your light bulb light up.

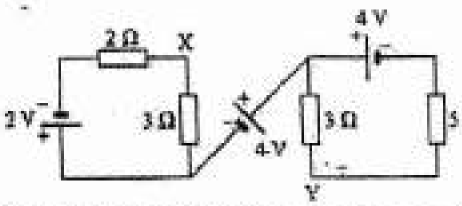
Result: as long as blades rotate bulb continues to glow.

KS INSTITUTE OF TECHNOLOGY BANGALORE

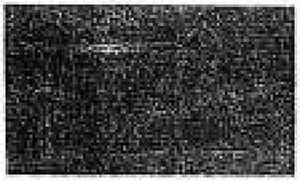
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18ELE13-BASIC ELECTRICAL ENG.
QUESTION BANK
MODULE-I

1. State and explain Kirchhoff's Laws.
2. State and explain Ohm's Law and mention its Limitations.
3. A circuit consists of 2 parallel resistors having resistances 20Ω and 30Ω respectively connected i series with a 15Ωresistor. If the current through 30Ωresistor is 1.2A,Find (i)Currents in 20Ω an 15Ω resistors(ii)The voltage across the whole circuit(iii)voltage across 15 Ω resistor and 20 resistor(iv) total power consumed in the circuit.
4. In the parallel arrangement of resistors shown the current flowing in the 8ohm resistor is 2.5A Find current in others resistors, resistor X, the equivalent resistance.
5. If the total power dissipated in the circuit shown is 18W, find the value of 'R' and its current.



6. Show that the equivalent resistance of two resistors connected is the ratio of product of these tw resistances divided by the sum of those two resistance values.
7. Find the value of resistance R as shown in the figure below. So that the current drawn from th source is 250 mA. All the resistance are in ohms.



8. Define Average value and RMS value of alternating current and derive their relation wit maximum value if alternating quantity is sinusoidal.
9. Define Form factor and Peak factor.
10. An alternating current has a peak value of 141.4A and its frequency is 100Hz. Write down th mathematical expression for the current.
11. An alternating emf is mathematical expressed as e=200sin314t. Find (i) Amplitude (ii) Frequenc (iii) Instantaneous value when t-1/200sec.
12. An alternating current has an effective value of 200A. If its frequency is 25Hz, find its averag value and write down the expression for the current.
13. Show that an alternating quantity can be represented by a rotating vector.

KS INSTITUTE OF TECHNOLOGY BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18ELE13-BASIC ELECTRICAL ENG.
QUESTION BANK
Module 2

1. Show that the average power consumed in pure capacitances is zero. Draw the neat wave form for the voltage, power and current.
2. Show that the average power consumed in pure inductance is 0. Draw the neat wave form for the voltage, power and current.
3. Derive an expression for the current, impedance and power of an ac circuit consisting of a resistance, inductance connected in series and also draw vector diagram and waveform.
4. Derive an expression for the current, impedance and power of an ac circuit consisting of a resistance and capacitance connected in series and also draw vector diagram and waveform.
5. Show that power consumed in RC series circuit is VIcosΦ. Draw the waveform for the voltage, current and power.
6. An alternating voltage (80+j60)V is applied to a circuit and current flowing is (-4+j10)A. Find (i) the impedance of the circuit (ii) Phase angle (iii) Power consumed by the circuit.
7. A coil of power factor 0.6 is in series with 100μF capacitor. When connected to 50Hz supply, the potential difference across the coil is equal to potential difference across the capacitor. Find the resistance and inductance of the coil.
8. List the advantages of 3-phase systems over single phase systems.
9. Establish the relationship between phase and line value of voltage and currents in 3phase, delta connected circuit. Show the phasor diagram neatly.
10. Explain the generation of 3phase ac voltage.
11. Establish the relationship between phase and line value of voltage and currents in 3phase, star connected circuit.
12. Show that the power in a balanced 3phase circuit can be measured by two wattemeters. Draw the circuit and vector diagram.
13. Define phase sequence and list out the advantages of 3 phase system as compared to single phase systems.
14. A balanced star connected load of 8+j6 ohms per phase is connected to 3phase 230V supply. Find the line current, power factor, power reactive volt ampere and total volt ampere.
15. A 3phase delta connected balanced load consumes a power of 60KW taking a lagging current of 200 A at a line voltage of 400V, 50Hz. Find parameter of each phase.

KSIT

KS INSTITUTE OF TECHNOLOGY BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18ELE15-BASIC ELECTRICAL ENGINEERING

MODULE 3

SINGLE PHASE TRANSFORMERS

1. Derive the condition for which the efficiency of a transformer is maximum.
2. Explain the construction and working principle of a transformer with a neat sketch.
3. Explain principle of operation of a single-phase transformer and derive the EMF equation.
4. A single-phase transformer has 400 turns primary and 1000 secondary turns. The net cross-sectional area of the core is 60cm^2. The primary winding is connected to a 500V, 50Hz supply. Find peak value of flux density, emf induced in the secondary winding.
5. The maximum efficiency at full load and unity p.f of a single phase 25KVA,500/1000V,50Hz transformer is 98%.Determine its efficiency at i)75% load,0.9p.f and ii)50% load,0.8p.f.
6. A 600KVA transformer has an efficiency of [illegible]% at full load, unity power factor and half full load, 0.9 pf. Determine its efficiency at 75% of full load,0.9pf.
7. Find the number of turns on the primary and secondary side of a 440/230 V, 50 Hz single phase transformer, if the net area of cross section of the core is 30 cm2 and the maximum flux density is 1Wb/m2.
8. A single-phase transformer working at 0.8 pf has efficiency 94% at both three fourth full load and full load of 600 kW. Determine the efficiency at half full –load, unity power factor.
9. A single phase, 20KVA transformer has 1000 primary turns and 2500 secondary turns. The net cross sectional area of the core is 100cm2. when the primary winding is connected to 500V,50Hz supply, calculate) the maximum value of the flux density in the core, the voltage induced in the secondary winding and the primary and the secondary full load currents.

DOMESTIC WIRING

1. Briefly discuss the various types of wiring schemes and their application.
2. Draw a schematic diagram to show the control of two lamps and a fan with independent switches.
3. With a neat circuit diagram explain two-way control of an equipment using two-way switches. Also write the truth table for the circuit. What is the difference between two-way two wire control and two-way three wire control?
4. Explain various protective devices used in the electrical wiring schemes.
5. Why is earthing required? Briefly discuss the different earthing schemes.
6. What is an electric shock? What are the first aid measures to be taken in the event of a shock?
7. List the Prevention methods to be taken to prevent electrical shocks.

KS INSTITUTE OF TECHNOLOGY BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18ELE15-BASIC ELECTRICAL ENGINEERING

MODULE-4

DC GENERATORS AND DC MOTORS

1. Explain with diagram the construction features of various parts of a DC Machine.
2. Derive the expression for EMF of a DC generator.
3. A 4 pole generator with wave wound armature has 51 slots, each having 24 conductors, the flux per pole is 0.01 Wb. At what speed must the armature rotate to give a induced emf of 220V. What will be the voltage developed if the winding is lap and armature rotates at same speed.
4. A 30 KW, 300 V DC shunt generator has armature and field resistance of 0.05ohms and 100 ohm respectively. Calculate the total power developed by armature when it delivers full output power.
5. The emf generated in the armature of a shunt generator is 625 V, when delivering its full load current of 400A to the external circuit. The field current is 6 A and the armature resistance is 0.06 ohms. What is the terminal voltage?
6. Explain the significance of back EMF in a DC motors.
7. Derive the expression for armature torque developed in a dc motor.
8. Explain the characteristics of DC series motor with a neat diagram.
9. Explain the characteristics of DC shunt motor with a neat diagram.
10. Mention the application of DC series, DC shunt and DC compound motors.
11. A 220 V series motor is taking a current of 40A, resistance of armature 0.5ohms, resistance of series field is 0.25 ohms. Calculate voltage at the brushes, back Emf, power wasted in armature, and power wasted in series field.
12. A DC shunt motor takes an armature current of 110A at 480V. The armature resistance is 0.2 ohms, the machine has 6 poles, and armature is lap connected with 864 conductors. The flux per pole is 0.05 Wb. calculate speed and torque developed by the armature.
13. A 4 pole DC shunt motor takes 22.5 A from 250V supply Ra =0.5ohms, Rsh=125ohms, the armature is wave wound with 300 conductors. If the flux per pole is 0.02Wb, calculate speed, torque and power developed

KS INSTITUTE OF TECHNOLOGY BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18ELE15-BASIC ELECTRICAL ENGINEERING

MODULE-4

DC GENERATORS AND DC MOTORS

1. Explain with diagram the construction features of various parts of a DC Machine.
2. Derive the expression for EMF of a DC generator.
3. A 4 pole generator with wave wound armature has 51 slots, each having 24 conductors, the flux per pole is 0.01 Wb. At what speed must the armature rotate to give a induced emf of 220V. What will be the voltage developed if the winding is lap and armature rotates at same speed.
4. A 30 KW, 300 V DC shunt generator has armature and field resistance of 0.05ohms and 100 ohm respectively. Calculate the total power developed by armature when it delivers full output power.
5. The emf generated in the armature of a shunt generator is 625 V, when delivering its full load current of 400A to the external circuit. The field current is 6 A and the armature resistance is 0.06 ohms. What is the terminal voltage?
6. Explain the significance of back EMF in a DC motors.
7. Derive the expression for armature torque developed in a dc motor.
8. Explain the characteristics of DC series motor with a neat diagram.
9. Explain the characteristics of DC shunt motor with a neat diagram.
10. Mention the application of DC series, DC shunt and DC compound motors.
11. A 220 V series motor is taking a current of 40A, resistance of armature 0.5ohms, resistance of series field is 0.25 ohm. Calculate voltage at the brushes, back Emf, power wasted in armature, and power wasted in series field.
12. A DC shunt motor takes an armature current of 110A at 480V. The armature resistance is 0.2 ohms, the machine has 6 poles, and armature is lap connected with 864 conductors. The flux per pole is 0.05 Wb, calculate speed and torque developed by the armature.
13. A 4 pole DC shunt motor takes 22.[illegible] A from 250V supply Ra 0.5ohms, Rsh=125ohms, the armature is wave wound with [illegible]00 conductors. If the flux per pole is 0.02Wb, calculate speed, torque and power developed.

KS INSTITUTE OF TECHNOLOGY BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

18ELE15-BASIC ELECTRICAL ENGINEERING
MODULE-5

THREE PHASE SYNCHRONOUS GENERATORS

1. Explain construction and working principle of synchronous generator.
2. List advantages of rotating magnetic field over Stationary armature.
3. A 3phase, 50 Hz, 16 pole generator with star connected winding has 144 slots with conductor per slot is 10. The Flux per pole is 24.8 mWb is sinusoidally distributed. The coils are full pitched. Find the speed, line EMF.
4. From basic principles, arrive at an expression for the EMF /phase induced in an alternator.
5. With sketches explain the constructional features of salient pole and non-salient pole alternators. Where are the two types used?
6. Calculate the induced EMF /phase in a 4 pole, 3ϕ, 50Hz star connected alternator with 72 slots and 15 conductors per slot. The flux/pole is 0.06Wb. Assume the winding factor to be 0.95, full pitch winding & sinusoidal distribution of flux.
7. Determine the phase & line values of the induced EMF in a 4 pole, 3ϕ, 50Hz star connected alternator with 36 slots and 30 conductors per slot. The flux/pole is 50mWb. Assume the winding factor to be 0.95. What is the line EMF if connected in delta?
8. A 20 pole, 3ϕ, 50Hz star connected stator winding has 180 slots on the stator. Each slot consists of 8 conductors. The flux/pole is 25mWb and is sinusoidally distributed. The coils are full-pitched. Calculate i) speed, ii) generated EMF /phase and iii) line EMF.
9. With usual notations, derive the relation f=PN/120.

THREE PHASE INDUCTION MOTORS

1. What is slip in an induction motor? Explain why slip is never zero in an induction motor.
2. With a neat diagram, explain the working principle of 3 - φ induction motor.
3. Why does an induction motor need a starter?
4. Explain construction and working principle of star-delta starter.
5. The frequency of the EMF in the stator of a 4-pole induction motor is 50Hz and in the rotor is 1. 5Hz.What is the slip and at what speed is the motor running?

6. An 8-pole alternator runs at 750rpm and supplies power to a 6-pole induction motor which runs at 970rpm. What is the slip of the induction motor?
7. A 10-pole induction motor is supplied by a 6 – pole alternator which is driven at 1200 rpm. If the motor runs with a slip of 3%, what is its speed?
8. How is a rotating magnetic field produced in the air gap of a 3ϕ induction motor?
9. What is squirrel cage and wound-rotor induction motors? What are their relative advantages and disadvantages? Mention their applications.
10. Why does an induction motor require a starter? With a neat diagram explain the principle of operation of a star-delta starter.
11. A 3ϕ, 8 pole, 60Hz induction motor has a slip of 3% at full load. Find the synchronous speed and the frequency of rotor current at full load.
12. What is the maximum possible rpm of a 50Hz induction motor? Why?

Challenging questions for toppers on MODULE-1

Subject: Basic Electrical Engineering
Subject code: 18ELE13

1. Two batteries having emfs of 10v and 7v and internal resistances of 2ohm and 3ohm respectively are connected in parallel across a load of resistance 1ohm. Calculate (i) the current supplied by each battery (ii) the current through the load and (iii) the voltage across the load

2. Twelve 1 ohm resistances are used as edges to form a cube. What is the resistance between two diagonally opposite corners of the cube?

3. What are the requirements for the waveform to be classified as periodic?

4. A square wave has equal positive and negative peak values what are its average and effective values.

Reference:

2. Basic electrical engineering by \D C Kulshreshtha

CBCS SCHEME

USN ☐☐☐☐☐☐☐☐☐☐ **18ELE13/23**

First/Second Semester B.E. Degree Examination, Jan./Feb. 2021
Basic Electrical Engineering

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. State and explain Kirchhoff's laws. **(06 Marks)**

b. Define RMS value of an alternating quantity. Obtain an expression for it in terms of maximum value. **(06 Marks)**

c. Find : i) Current in 15Ω resistor ii) Voltage across 18Ω resistor iii) Power dissipated in 7Ω resistor as shown in circuit diagram. Fig.Q1(c).

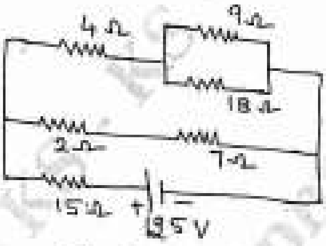


Fig.Q1(c) **(08 Marks)**

OR

2 a. Define average value of a sinusoidally varying current and find its relation with its maximum value. **(06 Marks)**

b. State ohm's law and mention its limitations. **(06 Marks)**

c. For the current waveform shown in Fig.Q2(c).
Find : i) Peak current ii) Average value iii) Periodic time iv) Frequency v) Instantaneous Value at t = 3ms.

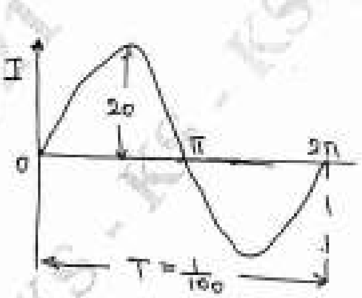


Fig.Q2(c) **(08 Marks)**

Module-2

3 a. Show that pure inductance does not consume any power. Draw the wave forms of voltage, current and power. When an alternating voltage is applied to a pure inductance. **(06 Marks)**

b. In a three phase delta connection, find the relation between line and phase values of currents and voltages. Also derive the equation for three phase power. **(06 Marks)**

c. A series R-L-C circuit is composed of a 100 ohms resistance, 1H inductance and 5μF capacitance. A voltage of V(t) = 141.4 cos 377t volts is applied to the circuit. Determine the current and voltages V_R, V_L and V_C. **(08 Marks)**

OR

4 a. Derive an equation for the power consumed by an R – L series circuit. Draw the wave form of voltage, current and power. (06 Marks)

b. When a three phase balanced impedances are connected in star, across a 3 phase 415V, 50Hz supply, the line current drawn is 20A, at a lagging p.f of 0.4. Determine the parameters of the impedance in each phase. (06 Marks)

c. Show that two wattmetres are sufficient to measure power in a 3-phase balanced star connected circuit with the aid of neat circuit diagram and phasor diagrams. (08 Marks)

Module-3

5 a. Give the constructional details of core type and shell type of transformer. (06 Marks)

b. Derive the condition for which the efficiency of a transformer is maximum. (06 Marks)

c. With a circuit diagram, explain the working of a two-way and three way control of lamp. (08 Marks)

OR

6 a. With a neat figure, explain pipe earthing. (06 Marks)

b. What are the various loses that occur in a transformer? Give the equations for these loses. (06 Marks)

c. A single phase transformer working at 0.8p.f has an efficiency of 94% at both three-fourth full load and full load of 600Kw. Determine the efficiency at half full load, unity power factor. (08 Marks)

Module-4

7 a. Derive the EMF equation of a DC generator. (06 Marks)

b. What is back emf in a DC motor? What is its significance? (06 Marks)

c. A 4 pole, DC shunt generator with lap connected armature has field and armature resistance of 50Ω and 0.1Ω respectively, if the generator supplies sixty 100V, 40W lamps, calculate the total armature current, the current in each armature conductor and the generated EMF. Take 1V per brush as contact drop. (08 Marks)

OR

8 a. Derive an equation for the torque developed in the armature of a DC motor. (06 Marks)

b. Sketch Ta V/S I_a and N V/S I_a characteristics of : i) Shunt motor ii) Series motor
Mention two applications of each motor. (06 Marks)

c. A 4pole, 220V lap connected DC shunt motor has 36 slots, each slot containing 16 conductors it draws a current of 40A form the supply. The field resistance and armature resistances are 110Ω and 0.1Ω respectively. The motor develops an output power of 6KW. The flux per pole is 40m Wb. Calculate :
i) The speed ii) The torque developed by the armature iii) The shaft torque. (08 Marks)

Module-5

9 a. Derive the emf equation of an synchronous generator. (06 Marks)

b. Define slip of an induction motor and derive expression for frequency of rotor current. (06 Marks)

c. With neat sketches explain the construction of two types of synchronous generator. (08 Marks)

OR

10 a. Explain clearly the working principle of a three phase induction motor. (06 Marks)

b. A 6pole, 3 phase star connected alternator has an armature with 90 slots and 12 conductor per slot. It revolves at 1000 rpm, the flux per pole being 0.5 Wb. Calculate the emf generated if the winding factor is 0.97 and all the conductors in each phase are in series the coil is full pitched. (06 Marks)

c. Explain the concept of rotating magnetic field in case of a 3 phase induction motor. (08 Marks)

CBCS SCHEME

USN 1KS18EC056

18ELE13/23

First/Second Semester B.E. Degree Examination, Dec.2019/Jan.2020
Basic Electrical Engineering

Time: 3 hrs.

Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. State Ohm's Law. Mention its limitations. **(06 Marks)**

b. Find E_1, E_2 and I when the power dissipated in the 5Ω resistor is 125W.(Ref. Fig.Q1(b)). **(07 Marks)**

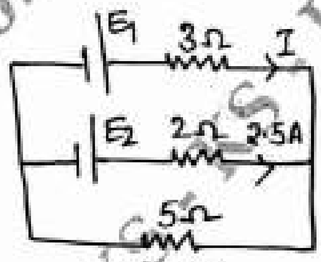


Fig.Q1(b)

c. Define RMS value of alternating current, show that its value is proportional to maximum value. **(07 Marks)**

OR

2 a. Two 12V batteries with internal resistances 0.2Ω and 0.25Ω respectively are joined in parallel and a resistance of 1Ω is placed across the terminals. Find the current supplied by each battery. **(07 Marks)**

b. The equation for an AC voltage is given as $V = 0.04\sin(2000t + 60°)$V. Determine the frequency, the angular frequency, instantaneous voltage when t = 160μs. What is the time represented by a 60° phase angle. **(06 Marks)**

c. Explain the generation of 1ϕ AC induced emf with suitable diagram. **(07 Marks)**

Module-2

3 a. Show that in a pure inductor the current lags behind the voltage by 90°. Also draw the voltage and current waveforms. **(06 Marks)**

b. Given V = 200 sin 377 volts and i = 8 sin (377t – 30°)Amps for an AC circuit, determine : i) Power factor ii) True power iii) Apparent power iv) Reactive power indicate the unit of power calculated. **(08 Marks)**

c. 3 similar coils each having resistance of 10Ω and reactance of 8Ω are connected in star across 400V, 3ϕ supply. Determine : i) Line current ii) Total power iii) Reading of each of the two wattmeters connected to measure power. **(06 Marks)**

OR

4 a. Show that the power in a balanced 3ϕ star connected circuit can be measured by 2 Wattmeter. Draw the circuit and vector diagram. **(08 Marks)**

b. Three coils each of impedance $20\angle 60°\Omega$ are connected in star to 3ϕ 400V, 50Hz supply. Find the reading on each of the 2 wattmeters connected to measure the power input. **(08 Marks)**

c. What is meant by power factor in AC circuits? What is its significance in AC circuits? **(04 Marks)**

Module-3

5 a. Derive an emf equation of transformer with usual notation. (06 Marks)

b. Explain the 2 way control and 3 way control of lamp with suitable circuit diagram and working table. (06 Marks)

c. A 40KVA, 1ϕ transformer has core loss of 450W and full load copper loss 850Watts. If the power factor of the load is 0.8. Calculate :

   i) Full load efficiency
   ii) Maximum efficiency at UPF
   iii) Load for maximum efficiency. (08 Marks)

OR

6 a. List different types of loss in a transformer and explain each one in brief. (06 Marks)

b. What is Earthing? Why earthing is required? With the help of sketch explain plate earting. (08 Marks)

c. Write a short note :

   i) MCB
   ii) Precautions agains electric shock. (06 Marks)

Module-4

7 a. With a neat sketch, explain the construction of the various parts of DC generator. (08 Marks)

b. Explain the significance of back emf in a DC motor. (06 Marks)

c. A shunt wound DC generator delivers 496A at 440V to load. The resistance of the shunt field coil is 110Ω and that of armature winding is 0.02Ω. Calculate the emf induced in the armature. (06 Marks)

OR

8 a. Derive the torque equation of DC motor with usual notations. (06 Marks)

b. A 6 pole lap-connected DC series motor, with 864 conductors, takes a current of 110A at 480V. The armature resistance and the series field resistance are 0.18Ω and 0.02Ω respectively. The flux per pole is 50mwb. Calculate :

   i) The speed ii) The gross torque. (07 Marks)

c. Derive emf equation of a DC generator. (07 Marks)

Module-5

9 a. Derive the emf equation of synchronous generator. (06 Marks)

b. With a circuit diagram, explain the working of star-delta starter for a 3ϕ induction motor. (07 Marks)

c. A 12 pole, 3ϕ alternator is coupled to an engine running at 500rpm. It supplies an induction motor which has a full load speed of1440rpm. Find the percentage slip and the number of poles of the motor. (07 Marks)

OR

10 a. Explain the concept of rotating magnetic field and show that resultant flux remains same at different instants of time. (07 Marks)

b. A 3ϕ, 50Hz, 20pole, salient pole alternator with Y-connected stator winding has 180 slots on the stator. There are 8 conductors per slot and the coils are full-pitched. The flues per pole is 25mwb. Assuming sinusoidally distributed flux, calculate :

   i) Speed ii) Generated emf per phase iii) Line emf. (07 Marks)

c. Describe the constructional features of synchronous generator with suitable diagram. (06 Marks

* * * * *

First/Second Semester B.E. Degree Examination, Aug./Sept.2020
Basic Electrical Engineering

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. State and explain Ohm's law. List out its limitations. **(06 Marks)**

b. For the figure shown in Fig.Q1(b), calculate the current in 2Ω resistor.

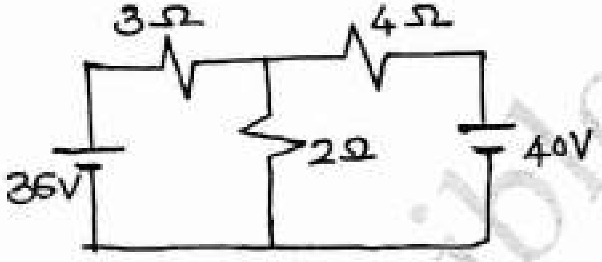


Fig.Q1(b) **(06 Marks)**

c. For the current wave, $e = 140\sin 314t$. Find:

(i) Peak current (ii) Average value (iii) Frequency
(iv) Time period (v) RMS value (vi) Instantaneous value at t = 3 ms
(vii) Form of factor (viii) Peak factor **(08 Marks)**

OR

2 a. State and explain Kirchoff's laws, as applied to D.C. circuit. **(06 Marks)**

b. Using series-parallel reduction, calculate the current supplied by the source for the circuit shown in Fig.Q2(b).

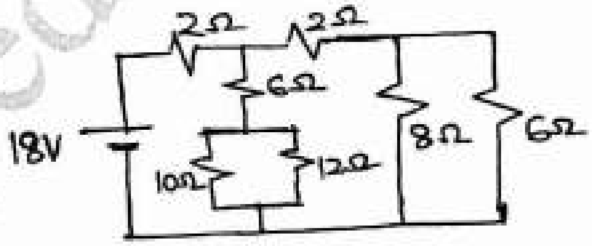


Fig.Q2(b) **(08 Marks)**

c. Derive the expression for RMS value of alternating quantity. **(06 Marks)**

Module-2

3 a. Show that power consumed by pure capacitor is zero. Draw the voltage, current and power waveform. **(07 Marks)**

b. Mention the advantages of 3-phase system over 1-phase system. **(05 Marks)**

c. A circuit consists of non-inductive resistance of 10Ω and inductance of 16 mH and a capacitance of 150 μF all connected in series. A supply of 100 V, 50 Hz is applied to the circuit. Find the current power factor and power consumed by the circuit. **(08 Marks)**

OR

4 a. Show that two wattmeters are sufficient to measure three phase power for a balanced star connected load. **(06 Marks)**

b. Derive an expression for impedance, phase angle and power for series R-L circuit supplied with AC. **(06 Marks)**

c. How is current 10A shared by three impedance $Z_1 = 2 - j5\,\Omega$, $Z_2 = 6.708\underline{|26.56}\ \Omega$, $Z_3 = 3 + j4\,\Omega$ all are connected in parallel? **(08 Marks)**

Module-3

5 a. State the principle of operation of transformer. Derive an expression for emf induced in transformer. **(06 Marks)**

b. Explain the operation of 3-way control of lamp with the help of diagram and functional table. **(06 Marks)**

c. Maximum efficiency at full load and unity power factor of a 1-phase, 25 kVA, 500/1000 V, 50 Hz transformer is 98%. Calculate its efficiency at: (i) 75% of full load, 0.9 p.f. (ii) 50% of full load, 0.8 p.f. (iii) 25% of full load, 0.6 p.f. **(08 Marks)**

OR

6 a. Briefly explain (i) Concealed wiring (ii) Service mains **(06 Marks)**

b. Write short notes on: (i) Fuse (ii) MCB **(06 Marks)**

c. A transformer working at unity power factor has an efficiency of 90% at both half load and at full load of 500 W. Determine the efficiency at 75% of full load. **(08 Marks)**

Module-4

7 a. With a neat diagram, explain the constructional details of DC Generator. **(06 Marks)**

b. Derive an equation of torque of DC motor. **(06 Marks)**

c. A 4-pole lap wound shunt generator delivers 200 A at terminal voltage of 250 V. It has field and armature resistance 50 Ω and 0.05 Ω respectively. Neglect brush drop. Calculate:
(i) Armature current (ii) Current per parallel path
(iii) emf generated (iv) Power developed **(08 Marks)**

OR

8 a. Explain the significance of back emf in DC motor. **(04 Marks)**

b. Derive an emf equation of DC generator. **(06 Marks)**

c. A 250 V DC shunt motor takes 6A line current on no load and runs at 1000 rpm. The field resistance is 250 Ω and armature resistance is 0.2 Ω. If the full load line current is 26A, calculate full load speed assuming constant air gap flux. **(10 Marks)**

Module-5

9 a. With neat sketch, explain the constructional details of 3-phase alternator. **(06 Marks)**

b. Explain the operating principle of three phase induction motor. **(06 Marks)**

c. A 6-pole, 3-phase star connected alternator has 90 slots and 8 conductors per slot and rotates at 1000 rpm. The flux per pole is 50 mWb. Find the induced emf across its lines. Assume winding factors of 0.97. **(08 Marks)**

OR

10 a. Explain the constructional details of 3-phase induction motor. Draw relevant sketches. **(08 Marks)**

b. Derive an expression for frequency of induced emf in case of 3-phase alternator. **(04 Marks)**

c. A 3-phase induction motor with 4-poles is supplied from an alternator having 6-poles and running at 1000 rpm. Calculate:
(i) Synchronous speed of induction motor (ii) Its speed when slip is 0.04
(iii) Frequency of rotor emf when speed is 600 rpm. **(08 Marks)**

CBCS SCHEME

USN ☐☐☐☐☐☐☐☐☐☐

18ELE13

First Semester B.E. Degree Examination, Dec.2018/Jan.2019
Basic Electrical Engineering

Time: 3 hrs. Max. Marks: [illegible]

Note: Answer FIVE full questions, choosing ONE full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. State and explain Kirchhoff's laws as applied to an electric circuit. ([illegible] Marks)

b. Given the network shown in Fig. Q1 (b), determine I_1, E, I_3 and I. If voltage across 9 Ω resistor is 27 V. ([illegible] Marks)

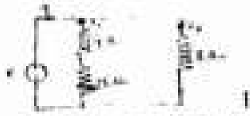


Fig. Q1 (b)

c. Derive the equation for root-mean-square value of an alternating current in terms of maximum value. (06 Marks)

OR

2 a. Define the (i) Frequency (ii) Form factor & (iii) Peak factor of sinusoidally varying voltage. (06 Marks)

b. The instantaneous values of two alternating voltages are represented respectively by $V_1 = 60\sin\theta$ volts and $V_2 = 40\sin\left(\theta - \frac{\pi}{3}\right)$ volts. Derive an expression for instantaneous value of : (i) the sum (ii) the difference of these voltages. (08 Marks)

c. For the network shown in Fig. Q2 calculate the power consumed by each resistor. (06 Marks)

Fig. Q2

Module-2

3 a. Show that voltage and current in pure resistive circuit are in phase and power consumed in the circuit is equal to product of rms voltage and current. The circuit is excited by the a.c. source. (06 Marks)

b. A resistance of 7 Ω is connected in series with a pure inductance of 31.8 mH and the circuit is connected to a 100 [illegible] Hz, sinusoidal supply. Calculate (i) Circuit current (ii) Phase angle (iii) Power factor (iv) Power. (08 Marks)

c. Two wattmeters are used to measure power in a 3-phase balanced load. The wattmeter readings are [illegible].2 kW and 7.5 kW. Calculate (i) Total power (ii) Power factor and (iii) Total reactive power. (06 Marks)

OR

4 a. Deduce the relationship between the phase and the line voltages of a three phase star connected system. (06 Marks)

b. Three coils are connected in delta to a three phase, three wire, 400 V, 50 Hz supply and take a line current of 5 A at 0.8 p.f. lagging. Calculate the resistance and inductance of the coils. (06 Marks)

c. A coil having a resistance of 20 Ω and inductance of 0.0382 H, is connected in parallel with a circuit consisting of a 150 μF capacitor in series with 10 Ω resistor. The arrangement is connected to a 230 V, 50 Hz supply. Determine current in each branch. Also find total supply current. (08 Marks)

Module-3

5 a. Explain the construction of a single phase transformer. (06 Marks)

b. A 50 KVA single phase transformer has primary and secondary turns of 300 and 20 respectively. The primary winding is connected to a 2200 V, 50 Hz supply. Calculate (i) No load secondary voltage (ii) approximate values of the primary [illegible] secondary currents on full load (iii) Maximum value of flux density. (06 Marks)

c. With neat diagram, explain plate earthing. (08 Marks)

OR

6 a. Derive E.M.F equation of single phase transformer. (06 Marks)

b. With neat circuit and truth table, explain three way control of lamp. (06 Marks)

c. A 400 KVA transformer has a core loss of 2 kW and maximum efficiency at 0[illegible] p.f. occurs when the load is 240 kW. Calculate (i) The maximum efficiency at [illegible] power factor. (ii) the efficiency on full load at 0.71 power factor. ([illegible] Marks)

Module-4

7 a. Draw a labeled diagram of the cross section of a d.c. generator. What [illegible] the essential functions of the field coils, armature, commutator and brushes. (08 Marks)

b. A four-pole armature of d.c. generator has 624 lap-connected conductors and is driven at 1200 rpm. Calculate the useful flux per pole required to generate [illegible] E.M.F of 250 V. (06 Marks)

c. A four pole motor is fed at 440 V and takes an armature current of 50 A. The resistance of the armature circuit is 0.28 ohm. The armature winding [illegible] wave-connected with 888 conductors and useful flux per pole is 0.023 [illegible] emf and speed. (06 Marks)

OR

8 a. Obtain from first principles an expression for torque developed in d.c. motor. (06 Marks)

b. Explain characteristics of d.c. shunt motor. (06 Marks)

c. A shunt generator running at 500 rpm delivers 50 kW at 200 V. The armature and field resistances are 0.02 and 40 Ω respectively. Calculate generated E.M.F if brush drop of 1 V per brush (08 Marks)

Module-5

9 a. By means of a diagram, describe the main parts of synchronous generator with their functions. (08 Marks)

b. The stator of a 3-phase, 8 pole, 750 rpm alternator has 72 slots, each of which contains 10 conductors. Calculate the rms value of the emf per phase if flux per pole is 0.1 wb sinusoidally distributed. Assume full pitch coils and winding distribution factor of 0.96. (06 Marks)

c. A 4-pole, [illegible] V, 50 Hz induction motor runs at rated frequency and voltage. The frequency of the rotor current is [illegible]5 Hz. Find slip and running speed. (06 Marks)

OR

10 a. Deduce an expression for the frequency of rotor current in an induction motor. (06 Marks)

b. A 4-pole, 3-phase induction motor operates from a supply whose frequency is 50 Hz. Calculate:
   (i) Synchronous speed
   (ii) The speed of the rotor when the slip is 0.04.
   (iii) The frequency of the rotor current when the slip is 0.03.
   (iv) The frequency of the rotor current at standstill. (08 Marks)

c. Derive e.m.f equation for synchronous generator. (06 Marks)

* * * * *

CBCS SCHEME

USN

18ELE13/23

First/Second Semester B.E. Degree Examination, June/July 201

Basic Electrical Engineering

Time: 3 hrs.
Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Important Note: 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. State and explain Kirchoff's laws. (08 Marks)
b. Define form factor and peak factor. Obtain their values for a sinusoid voltage. (06 Marks)
c. A circuit consists of two parallel resistors having resistances [illegible] 20Ω and [illegible]0Ω respectively connected in series with a 15Ω resistor. If current through 15Ω [illegible], find.
i) Current through the branches
ii) Voltage across whole circuit
iii) Power consumed by 20Ω and 15Ω resistors. (06 Marks)

OR

2 a. Define average and rms value of a sinusoid. Also derive their respective expressions. (08 Marks)
b. Find the potential difference between X[illegible] for the network shown below Fig.Q2(b). (06 Marks)

Fig.Q.2(b)

c. State Ohm's Law. Mention its limitations. (06 Marks)

Module-2

3 a. Obtain the behaviour of voltage, current and power in a pure inductor. Connected to single phase ac supply. (08 Marks)
b. Show that, 3ϕ power [illegible] be measured using only two wattmeters for a balanced star connected load. (06 Marks)
c. A 3ϕ load of 3 equal impedances are connected in delta across a balanced 400V, 50Hz, 3 ϕ supply which takes a line current of 10A at a power factor of 0.7 lagging. Calculate: i) Phase current ii) [illegible] power in W iii) Power in VA iv) Power in VAR. (06 Marks)

OR

4 a. Obtain expressions for line and phase relationship of voltage, current and power in a 3ϕ star connected system. (08 Marks)
b. An alternating voltage of (160 + j120)V is applied to a circuit and the current is given by (6 + j8)A. Find the values of circuit elements by assuming f = 50Hz. Calculate the power factor of the circuit and power consumed by the circuit. (06 Marks)
c. A balanced 3ϕ star connected system draws power from 440V supply. The two Wattmeters connected indicate W_1 = 5kW and W_2 = 1.2kW. Calculate power, power factor and current in the circuit. (06 Marks)

Module-3

5 a. Explain electrical shock, its causes and precautions to be taken to prevent them. (08 Marks)
b. Discuss about various types of losses in a transformer. (06 Marks)
c. A 250KVA; 11,000/415 Volts, 50Hz, 1ϕ transformer has 80 turns on the secondary. Calculate:
i) Rated primary and secondary currents
ii) Number of primary turns
iii) Maximum value of flux in the core
iv) Voltage induced turn on secondary. (06 Marks)

OR

6 a. A 500kVA, 1ϕ transformer has an efficiency of 92% at full lo[illegible] [illegible] the full load, 0.9pf. Determine its efficiency at 80% of the full load and [illegible]95pf. (08 Marks)
b. Discuss about necessity of earthing, with a neat diagram expla[illegible] [illegible] earthi[illegible]. (06 Marks)
c. Write short notes on: i) Fuse ii) MCB. (06 Marks)

Module-4

7 a. With a neat sketch, explain construction of a DC mach[illegible] (08 Marks)
b. A 4 pole, 230V, DC series, wave connected armature w[illegible]1254 conductors, with flux per pole of 22mWb, takes 50A for motoring. The [illegible]ature and [illegible]es field coil resistances are 0.3Ω and 0.2Ω respectively. Calculate the speed and [illegible] [illegible]eloped in Watts. (06 Marks)
c. Brief on characteristics of a DC shunt mot[illegible] [illegible] [illegible]ms. (06 Marks)

[illegible]R

8 a. Define back emf and derive torque [illegible] for a D[illegible] motor. (08 Marks)
b. A shunt generator has 4 poles, l[illegible] wound [illegible] having 24 slots with 10 conductors/slot. If the flux/pole is 0.04Wb, and the sp[illegible] 1500rpm, calculate the emf generated in the armature. What would be the ge[illegible] emf [illegible] the winding is wave connected? (06 Marks)
c. Give the classification of DC generators w[illegible] their equivalent circuit diagrams. (06 Marks)

Module-5

9 a. Explain the principle of [illegible]ing of [illegible] induction motor. (08 Marks)
b. List the advantages of rota[illegible] field over rotating armature. (06 Marks)
c. A 3ϕ, 6-pole, sta[illegible]nnected alternator, revolves at 1000rpm. The stator has 90 slots and 8 conductors/slot. T[illegible] flux per pole is 0.05 Wb. Calculate the voltage generated by the machine if wind[illegible] factor [illegible] 0.96. (06 Marks)

OR

10 a. [illegible] the [illegible]ing principle of an alternator. Also derive its emf equation. (08 Marks)
b. C[illegible] squirrel cage and slip ring types of rotors of an Induction motor. (06 Marks)
c. [illegible] 8 pole alternator runs at 750 rpm, supplies power to a 4 pole induction motor. The fre[illegible]ency of [illegible] rotor is 1.5Hz. What is the speed of the motor? (06 Marks)

* * * * *

KSIT, BANGALORE

DEPT. OF ELECTRONICS & COMMUNICATION

COURSE END SURVEY-BEE-2021-EVEN SEM

Timestamp	USN or Roll No.	Name of the Student	Semester & Section	Faculty Name	1. How good are you in applying Kirchoffs laws to DC circuits?	2. To what extent are you able to understand the working of DC machines and domestic wiring?	3. How efficient are you in solving the responses of 3 phase and single phase alternating	4. What is your level of knowledge about the working of synchronous generators?	5. How good are you in understanding the operational behaviour of Transformers and Induction motors?
11/22/21	1KS20EC001	abhishek j	2nd sem D sec	Vishalini Divakar	2	2	2	2	3
11/22/21	1KS20EC002	ADITI DUBEY	2nd sem D sec	Vishalini Divakar	3	3	3	3	
11/22/21	1KS20EC003	AFEEFA SHARIE	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC004	Ajay B G	2nd sem D sec	Vishalini Divakar	3	2	2	2	3
11/22/21	1KS20EC005	Ajay Girish	2nd sem D sec	Vishalini Divakar	3	2	2	2	3
11/22/21	1KS20EC006	Akash	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC007	ASHRIT MADHAV VADIRAJ	2nd sem D sec	Vishalini Divakar	2	2	2	2	3
11/22/21	1KS20EC008	B.S.HEMASHREE	2nd sem D sec	Vishalini Divakar	3	3	3	3	
11/22/21	1KS20EC009	Bharath M	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/22/21	1KS20EC010	BHAVITHA B	2nd sem D sec	Vishalini Divakar	3	1	1	1	2
11/22/21	1KS20EC011	BHUVANESHWARI K	2nd sem D sec	Vishalini Divakar	3	2	1	1	2
11/23/21	1KS20EC012	CHAITANYA.K	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/23/21	1KS20EC013	CHAITHRA K	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/23/21	1KS20EC015	CHALLAGUNDLA UMA	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/22/21	1KS20EC016	CHAYA S	2nd sem D sec	Vishalini Divakar	3	1	1	1	2
11/22/21	1KS20EC017	CHETHAN G	2nd sem D sec	Vishalini Divakar	3	2	1	1	2
11/22/21	1KS20EC018	CHETHAN KUMAR J	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/22/21	1KS20EC019	CHETHAN KUMAR T	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC020	DARSHAN K	2nd sem D sec	Vishalini Divakar	3	3	3	3	2

11/22/21	1KS20EC021	DARSHAN KUMAR S	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/22/21	1KS20EC022	DEEPAK S	2nd sem D sec	Vishalini Divakar	3	1	1	1	2
11/22/21	1KS20EC023	DHAMINI J	2nd sem D sec	Vishalini Divakar	3	2	2	1	2
11/22/21	1KS20EC024	DHRUVA KUMAR S	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/22/21	1KS20EC025	Divya N	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/23/21	1KS20EC026	ESHWAR BIRADAR	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/23/21	1KS20EC027	G BHAVANA	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC028	Gagan.H.C	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC029	Gagana B S	2nd sem D sec	Vishalini Divakar	2	2	2	2	3
11/22/21	1KS20EC030	GANDHAMANI C M	2nd sem D sec	Vishalini Divakar	2	2	2	2	3
11/22/21	1KS20EC031	Gomitha R C	2nd sem D sec	Vishalini Divakar	3	3	3	3	2
11/22/21	1KS20EC032	Harini k	2nd sem D sec	Vishalini Divakar	2	2	2	2	3
11/22/21	1KS20EC033	Harshith gowda A	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC034	HARSHITHA.B.L	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC035	HARSHITHA J	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC035	Harshitha.J	2nd sem D sec	Vishalini Divakar	2	3	3	2	3
11/22/21	1KS20EC036	Harshitha N	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC037	INCHARA.P	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC038	JAMPULA CHAITHANYA	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC039	Jamuna s g	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC040	JANHAVI R	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC041	Jayanth H	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC042	K Jeevitha	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/23/21	1KS20EC043	K M AMSHUMANTH	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC044	K R Sahana	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/23/21	1KS20EC045	KAVANA.G.S	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC046	KAVYA S M	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC047	KEERTHANA.B.S	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC048	KIRAN DEV D	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC049	KIRAN V NARAYAN	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC050	K. Prathima	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC051	KUMAR KG	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC052	Kusuma. VR	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC053	M ARCHANA	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC054	MADIHA	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC055	MAHESH BIRADAR	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC056	MANASWINI K M	2nd sem D sec	Vishalini Divakar	2	2	2	2	2

11/23/21	1KS20EC057	MEGHASHREE M	2nd sem D sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC058	Mohan Krishna K	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC059	N.shreya	2nd sem D sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC060	N. Gowthami	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/23/21	1KS20EC061	NEHA C R	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC062	Neha Nagraj Airar	2nd sem E sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC063	Vasanth kumar	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1ks20ec064	Pavan c	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC065	Pavani TS	2nd sem E sec	Vishalini Divakar	3	2	2	1	2
11/22/21	1KS20EC066	Pradhyumna S Ka	2nd sem E sec	Vishalini Divakar	3	2	1	1	2
11/23/21	1ks20ec067	Praveen	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC068	Prema G	2nd sem E sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC069	Priyanka HC	2nd sem E sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC070	Priyanka K	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/22/21	1KS20EC071	PRIYANKA M	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/23/21	1KS20EC072	PUSHPA D T	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/22/21	1KS20EC073	Rahul Krishnan.V	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/22/21	1KS20EC074	Rahul R	2nd sem E sec	Vishalini Divakar	1	2	1	2	2
11/23/21	1KS20EC075	RAJATH K ACHAR	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/23/21	1KS20EC076	RAKSHITH.N.M	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/23/21	1Ks20Ec077	Rakshith. R	2nd sem E sec	Vishalini Divakar	2	1	2	2	2
11/22/21	1KS20EC078	RAKSHITHA A	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/22/21	1KS20EC079	RAMESHWAR	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/22/21	1KS20EC080	Ramya T	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC081	RAVI VAMSHI.D.N	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC082	ROHITH A K	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC083	S Arun Kumar	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC084	Sachin NM	2nd sem E sec	Vishalini Divakar	3	3	3	2	2
11/22/21	1KS20EC085	SADHANA SRINIVAS	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC086	SAKSHAM SINGH	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC087	Sandeep Y H	2nd sem E sec	Vishalini Divakar	3	2	2	3	3
11/23/21	1KS20EC089	SANJANA G	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/23/21	1KS20EC090	SANJANA.G	2nd sem E sec	Vishalini Divakar	3	3	3	3	3

11/23/21	1KS20EC091	Sanjana T Gadika	2nd sem E sec	Vishalini Divakar	2	2	2	2	2
11/23/21	1KS20EC091	SANJANA T	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/23/21	1KS20EC092	SHAKTHI	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC093	Sharath M	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC094	SHASHANK S	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC095	Shivareddy BA	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC096	SHREYA H	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1kS20EC097	Shreyas M S	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/23/21	1KS20EC098	Shreyas P S RAO	2nd sem E sec	Vishalini Divakar	2	2	2	2	2
11/22/21	1KS20EC099	Shweta Deepak k	2nd sem E sec	Vishalini Divakar	3	2	2	3	2
11/22/21	1KS20EC100	SNEHA A S	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC101	Sonika.R	2nd sem E sec	Vishalini Divakar	2	3	2	2	3
11/22/21	1KS20EC102	SUMANA N	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC103	SUMUKHA.S	2nd sem E sec	Vishalini Divakar	3	2	2	2	2
11/22/21	1KS20EC104	Suraksha. N	2nd sem E sec	Vishalini Divakar	3	2	3	2	2
11/22/21	1KS20EC105	Tarun Prasanna	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/23/21	1KS20EC106	TEJAS N REDDY	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC107	Thummalagirishch	2nd sem E sec	Vishalini Divakar	3	2	3	3	2
11/22/21	1KS20EC108	Uday C H	2nd sem E sec	Vishalini Divakar	3	2	3	2	2
11/23/21	1KS20EC109	UJJWAL NAIDU	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC110	Vaishnavi A	2nd sem E sec	Vishalini Divakar	3	3	2	3	3
11/23/21	1KS20EC111	Vaishnavi vh	2nd sem E sec	Vishalini Divakar	2	3	3	3	3
11/22/21	1KS20EC112	N Varsha	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC113	Vijayalakshmi K	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC114	VINAY S P	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC115	VINAY SAGAR V	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC116	VINEETH M S	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
11/22/21	1KS20EC117	Yashilaa S	2nd sem E sec	Vishalini Divakar	3	3	3	3	1
11/22/21	1KS20EC118	YASHWANTH Y	2nd sem E sec	Vishalini Divakar	3	3	3	3	3
				No.of 1 s	**1**	**4**	**7**	**8**	**1**
				Total	**118**	**118**	**118**	**118**	**118**
				% age	**99.1525424**	**96.6101695**	**94.068**	**93.220339**	**99.15254**
				Average	**96.440678**				

(Course In charge)

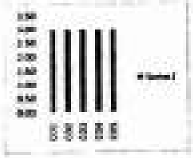
K.S. INSTITUTE OF TECHNOLOGY, BANGALORE

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGG

/ SEMESTER	II B
SE TITLE	BASIC ELECTRICAL ENGG
SE CODE	18ELE23
EMIC YEAR	2020-21
E	2020-21

Significance

CO	Score Index out of 3
CO1	3.00
CO2	2.75
CO3	3.00
CO4	3.00
CO5	3.00



						Co-Po Mapping Table								
COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	1
CO2	3	2											2	1
CO3	3	2				2	2						2	1
CO4	3	2				1							2	1
CO5	3	2				1							2	1
AVG	3.00	2.00	-	-	-	1.33	2.00	-	-	-	-	-	2.00	1.00

PO Attainment

COS	CO Attainment	CO Attd.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
18ELE22-CO1	3.00	Y	3.00	2.00											2.00	1.00
18ELE22-CO2	3.00	Y	3.00	2.00											2.00	1.00
18ELE22-CO3	3.00	Y	3.00	2.00				2.00	2.00						2.00	1.00
18ELE22-CO4	3.00	Y	3.00	2.00				1.00							2.00	1.00
18ELE22-CO5	3.00	Y	3.00	2.00				1.00							2.00	1.00
Average			3.00	2.00	-	-	-	1.33	2.00	-	-	-	-	-	2.00	1.00

(Course Incharge)

Basic Electrical Engg.

Introduction - DC CIRCUITS.

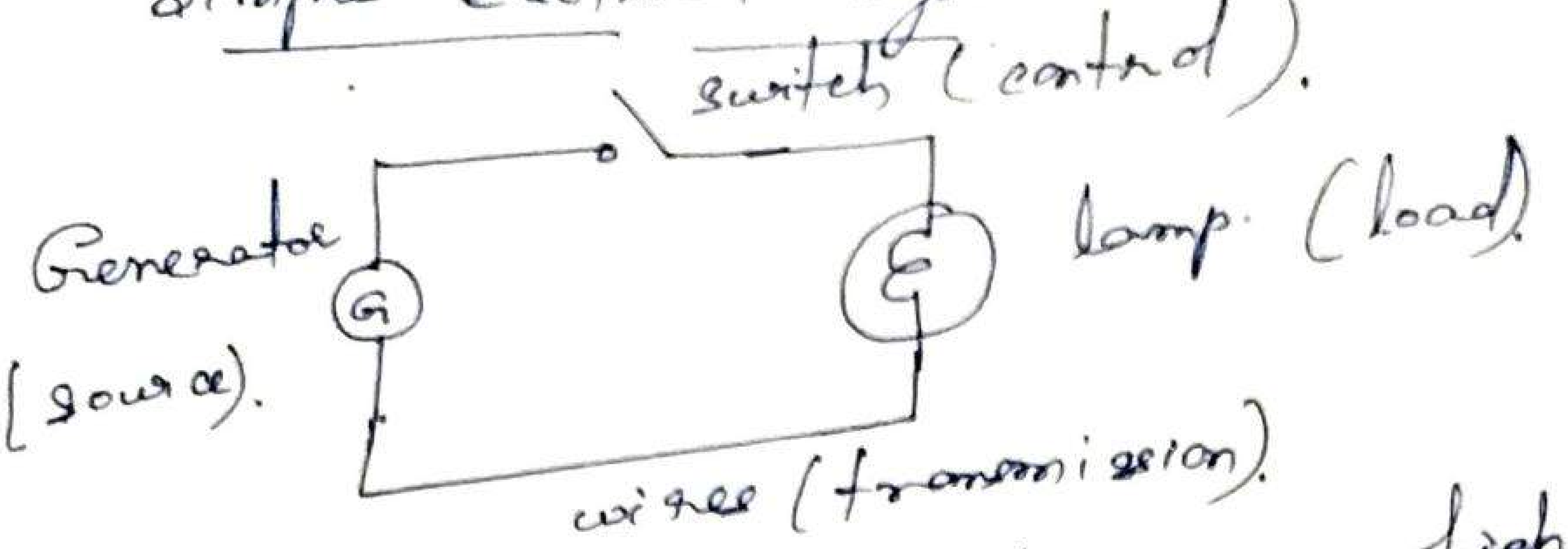
1. Electrical engineering can be summarized into 4 categories -

1. The generation (production) of electrical energy.
2. The transmission of electrical energy.
3. The application of " —,, —" —(utilization)
4. The control of " — ,, —,, —(for measurement)

2. An electrical system has 4 constituent parts -

1. The Source — The function of the source is to provi-de the energy for the electrical system. It may be a battery or a generator.
2. The load. — The function of the load is to absorb the electrical energy supplied by the source. Eg: lamps, heaters, and motors; appliances.
3. The transmission system — This conducts the energy from the source to the load. It consists of insulated wire.
4. The control apparatus — Its function is to control and the most simple control is a switch which permits the energy to flow or interrupt the flow.

Simple electrical system



3. Electrical energy – is the energy which is transmitted by flow of electric charge.

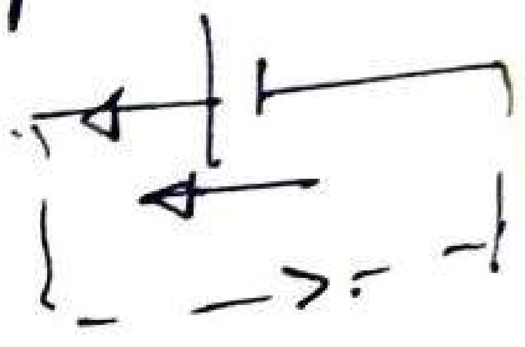
4. Electric charge is the excess of negative or +ve electricity on a body. If the excess is negative, the body is said to have a -ve charge and vice-versa. An e-l is charged with -ve electricity and a proton is charged with +ve electricity. An atom can have one or more electrons added to it or taken away. Mass of e-ls is negligible compared to protons. Hence removal of e-ls does not change the elemental classification but it disturbs the electrical balance.

If the atom has excess e-ls, it is said to be -vely charged. A charged atom is called an ion. If an atom loses electrons, it becomes +vely charged.

Current or movement of e^{-1}s.

· Electrons possess a certain potential energy and hence under a driving force, they move from high potential point to lower potential point. The flow of electrons is called current.

The conventional current flows in the opposite direction to that of electron current.



Conductor is a medium in which atoms can readily release ~~conductors~~ electrons and the transfer of e^{-1}s takesplace in them. eg: Cu, Al, silver

A material which does not readily permit electron flow is an insulator. eg: porcelain, rubber, nylon etc.

Semicondrs. have characteristics that belong to neither of the other two groups.

The necessary conditions for curnt. flow are-

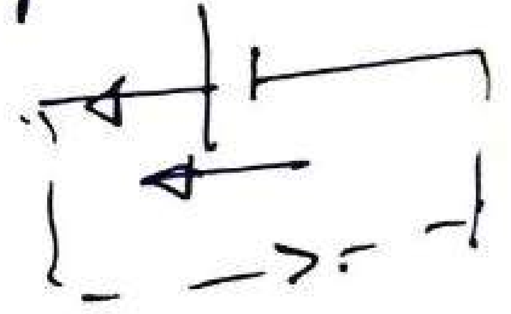
1. A complete ckt. around which the e^{-1}s move and return to the point of starting.
2. A driving ~~ckt~~ force to cause the continuous flow ie electromotive force (e.m.f).

E.m.f — represents the driving influence that causes a curnt. to flow. The emf is

Current or movement of e^{-1}'s.

- Electrons possess a certain potential energy and hence under a driving force, they move from high potential point to lower potential point. The flow of electrons is called current.

The conventional current flows in the opposite direction to that of electron current.



Conductor is a medium in which atoms can readily release ~~conductors~~ electrons and the transfer of e^{-1}'s takesplace in them. eg: Cu, Al, silver

A material which does not readily permit electron flow is an insulator. eg: porcelain, rubber, nylon etc.

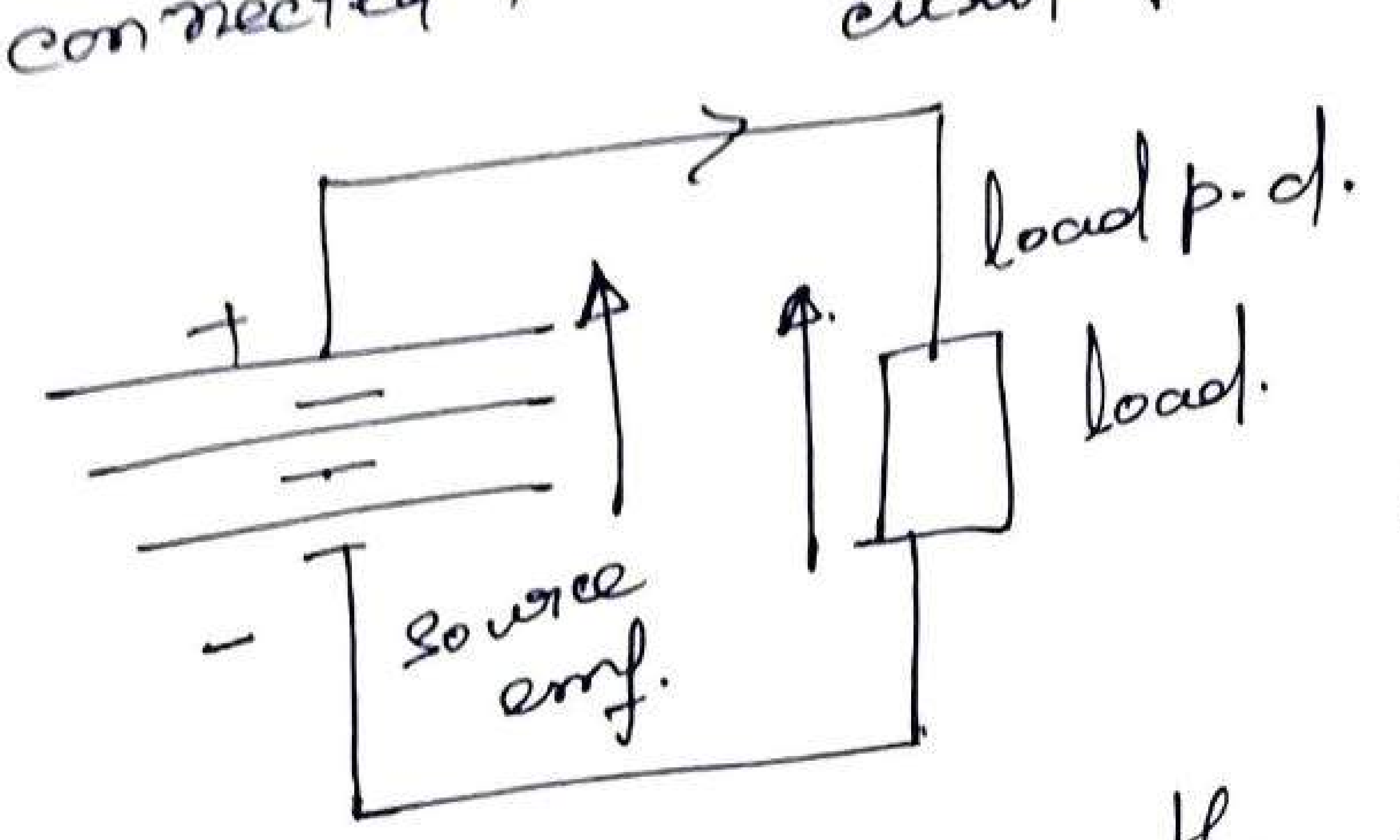
Semicondrs. have characteristics that belong to neither of the other two groups.

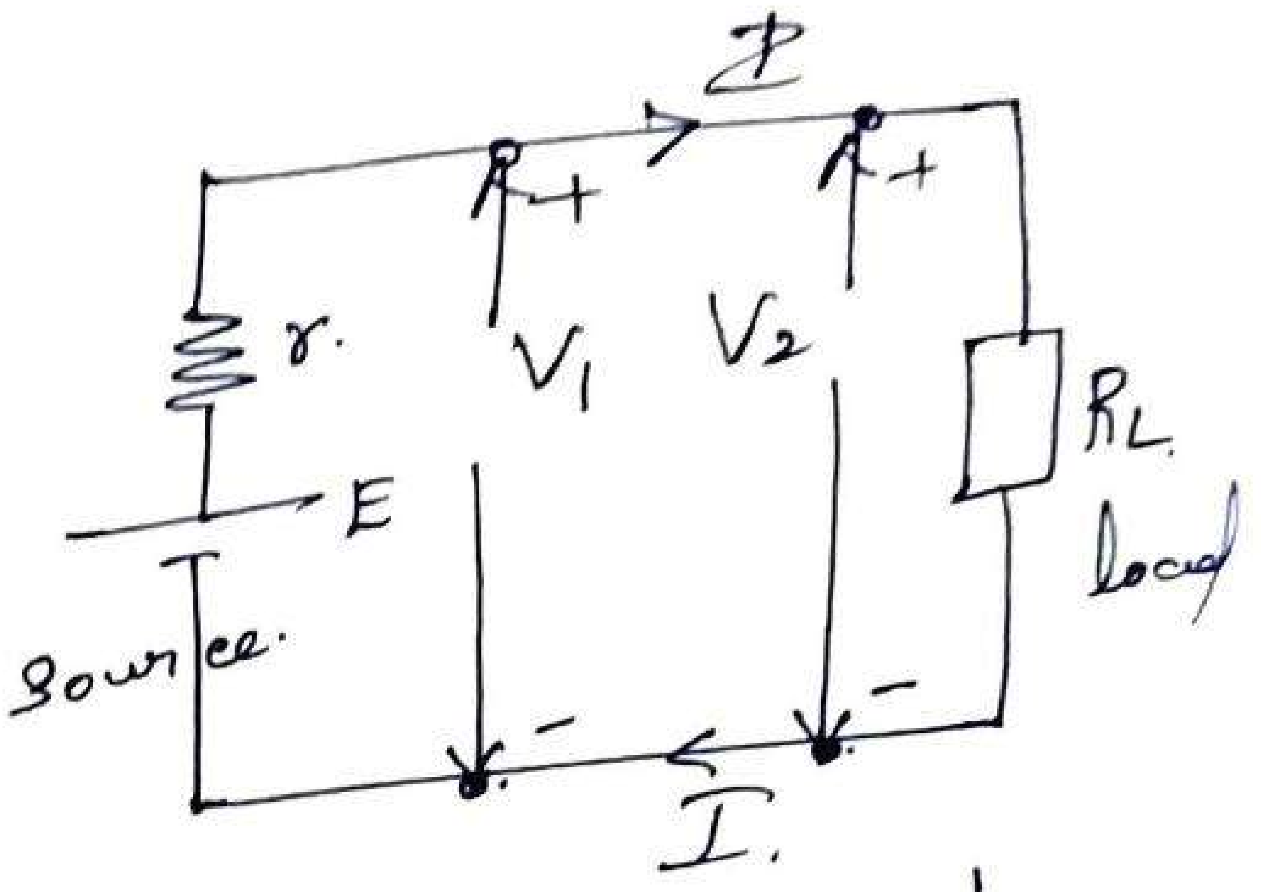
The necessary conditions for currt. flow are-

1. A complete ckt. around which the e^{-1}'s move and return to the point of starting.
2. A driving force to cause the continuous flow ie electromotive force (e.m.f).

E.m.f - represents the driving influence that causes a currt. to flow. The emf is not a force, but represents the energy expended during the passing of a unit charge through the source. It is a voltage and is measured in volts and it forces current to flow in a ckt.

Emf is the voltage of the source when nothing is connected to it.





The currt. flow leaves the source at the positive terminal and flows in the same direction as indicated by the source emf arrow.

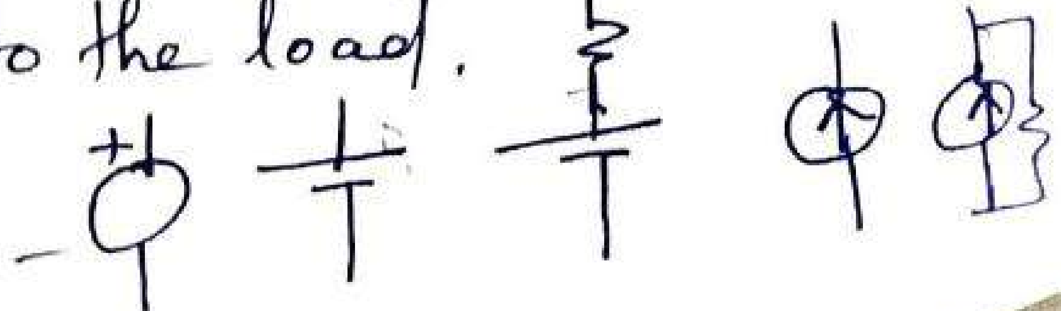
The currnt flow enters the load at the +ve terminal and ∴ in the opposite direction to that indicated by the load p.d arrow.

Terminal voltage is the voltage across the terminals of a source; V_1. $V_1 = E - Ir$.

Active elements – sources.   passive elements – sinks.

(voltage) Ideal source – T. V. remains constant irrespective of the currt. delivered to the load.

Ideal currt source → constant currt.



Current - The rate at whichthe electric charge is transfered across a point in conductor is known as the curnt. flowing through the conductor.

ie $I = \frac{dq}{dt} = \frac{q}{t}$.

The unit of curret is ampere.

Voltage or potential is defined as the amount of workdone to bring a unit +ve charge from infinity to that point.

Potential difference (pd or voltage)

The p.d between any two points of a charged condr. is the amount of work that has to be done to bring a unit positive charge from the point of lower potential to the point of higher potential.

If the energy required to move a charge of Q coulombs from point A to point B is W joules, the voltage between A & B is,

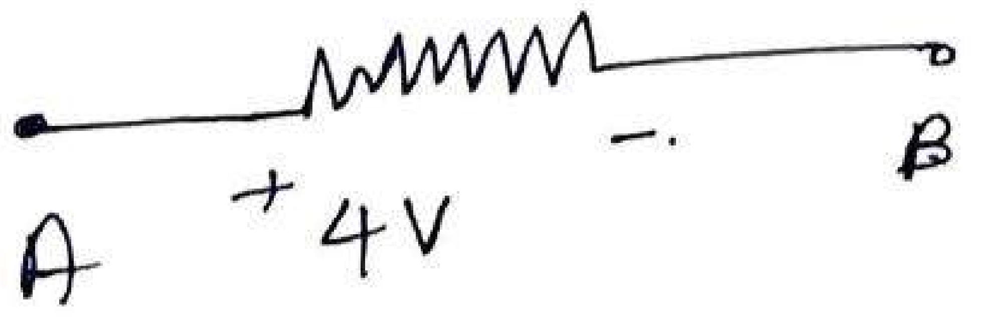
$$V_{AB} = \frac{W}{Q}.$$

1 volt = 1 Joule / coulomb.

The p.d is also referred to as the voltage between the two points of a conductor.

Voltage Rise or drop.

Fig (a)



There is a voltage rise of 4V. from B to A.

V_{AB} denotes the voltage of point A w.r.t B.

It is the voltage rise from B to A.

[~~It is the voltage drop from A to B.~~].

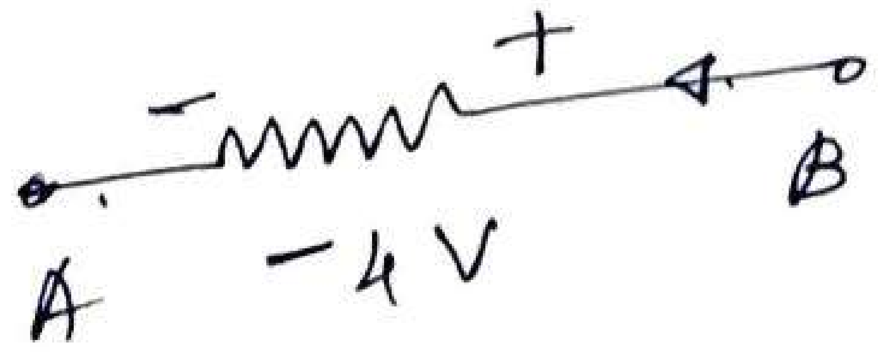
$V_{AB} = 4V$. ie point A is 4V above pt B

$V_{BA} = -4V$. point B is 4V below point A.

$V_{AB} = -V_{BA}$.

$V_{AB} = -4V$. A is at lower potential by 4V.

Fig (b)



In fig (b) There is a voltage drop of 4V from B to A.

Resistance and Resistivity.

The property of a material due to which it opposes the flow of current that it is called resistance. The unit is ohm (Ω).

The Resistance is directly ∝l to its length and inversely ∝l to its area of cross-section.

$R \propto \frac{l}{A}$ $R = \frac{\rho l}{A}$ $\rho \rightarrow$ resistivity.

Ω-mt

OHM's LAW.

Ohm's law states that the potential difference between the two ends of a conductor is directly proportional to the current flowing through it, provided its temperature remains constant.

$V \propto I$.

i.e, $V = RI$

where R is known as the resistance of the condr. in Ω.

$\frac{V}{I} = R$.

and $I = \frac{V}{R}$.

$I = GV$. where $G = \frac{1}{R}$

where G is the conductance of the condr. in siemens (S) (or $\mho$)

Limitations

(1) It does not hold good for non-linear devices like semiconductors and zener diodes.

(2) It does not hold good when the temperature varies.

(3) It is not applicable to non-metallic conductors such as silicon carbide, where $V = KI^m$. K, m are consts.

Electrical work

The movement of e-'s results in transfer of charge when there is a transfer of charge, there is electrical workdone; and its unit is joule.

One joule of work is done when moving a charge of 1 coulomb through a p.d. of 1 volt.

ie $W = V \times Q$. joules.

$V =$ p.d in volts

$Q =$ charge in C.

But $I = \frac{Q}{t}$ $W =$

$\therefore W = \underline{VIt}$ joules

t is time in seconds.

Electrical power

The rate at which electrical work is done in an electric ckt. is called electrical power.

Electrical power $P = \frac{\text{electrical workdone}}{\text{time}}$.

$= \frac{W}{t} = \frac{VIt}{t} =$

$P. = \underline{VI}$ Joules/sec $= VI$ watts.

$V = IR$ and $I = \frac{V}{R}$

$P = VI$ watts. $= I^2R = \frac{V^2}{R}$ watts.

Power is generally expressed in kilowatts and megawatts.

1kw = 1000w. 1 mw = 10^6 watts.

Electrical Energy (W).

Energy is the total amount of electrical work done in an electrical ckt, during a particular time t.

energy = power × time

$W = VIt$ joules.

$= VIt$ wattsec.

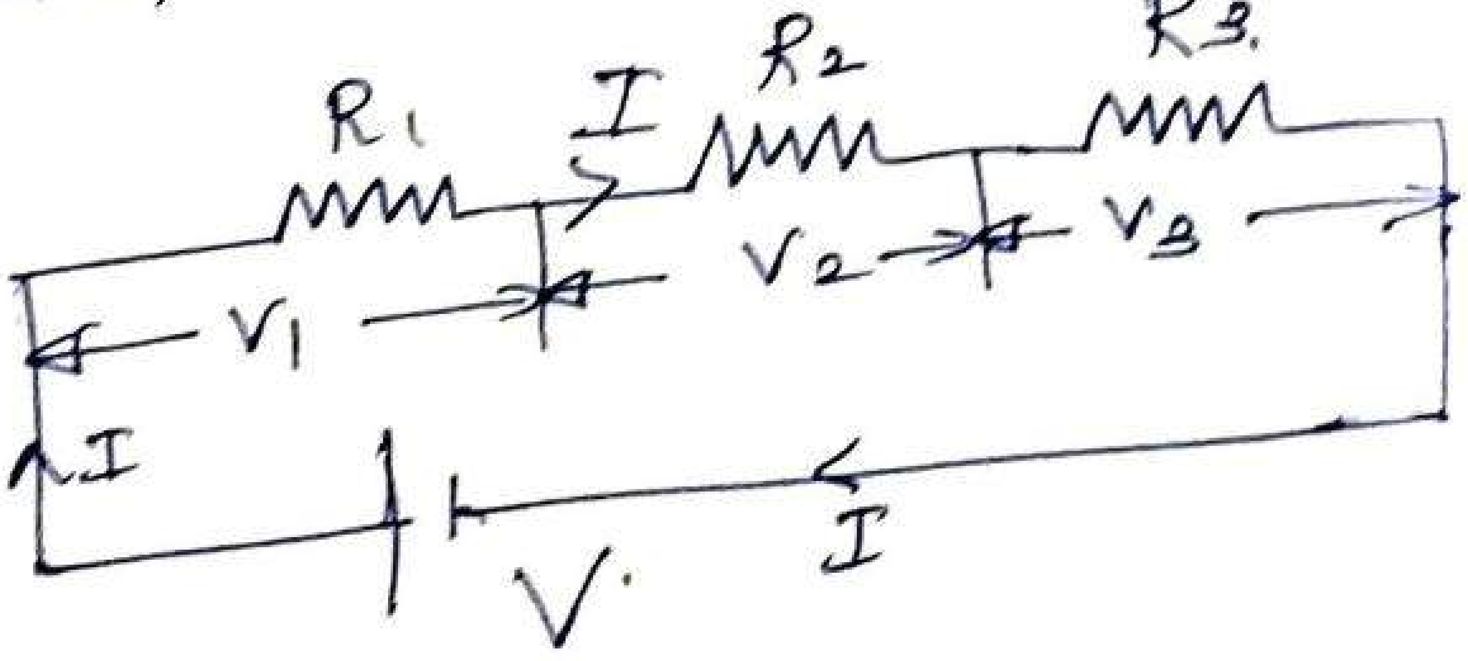
As the wattsec is a very small unit, energy is measured in watt-hour or kilo watt-hour (kwh).

$1\,kwh = 3600 \times 1000$ wattsec $= 3.6 \times 10^6$ joules

Hence the commercial unit of energy is kwh and it is called as. one unit.

Resistances in series

When the resistances are connected end to end, so that there is only one path for current flow, they are said to be connected in series. Then,



* Current through all resistors will be the same.

* The sum of the voltage drops across all resistors is equal to the applied voltage.

Fig. shows a series ckt. with 3 resistances. R_1, R_2, R_3 connected in series as shown. The currt. I flowsthrough all the resistors. Let V_1, V_2, V_3 be the voltage drops across resist-ors R_1, R_2, R_3 respectively. Then, the applied voltage

$$V_\phi = V_1 + V_2 + V_3.$$

$$= IR_1 + IR_2 + IR_3.$$

$$V = I(R_1 + R_2 + R_3).$$

$$\frac{V}{I} = R_1 + R_2 + R_3.$$

Accdg to ohm's law, $\frac{V}{I}$ is the total ckt resist. R.

$$\therefore \frac{V}{I} = \boxed{R = R_1 + R_2 + R_3.}$$

ie Total resistance = sum of individual resistances.

* Hence, when a no. of resistors are connected in series, the equivalent resist is the arithmetic sum of their individual resistances.

Resistances in parallel.

when resistors are connected such that, their starting ends are connected to one common point and finishing ends are connected to another common point, They are said to be connected in parallel. Then,

* voltage drop across each resistor is same.

* the sum of the currts through each is equal to the total current.

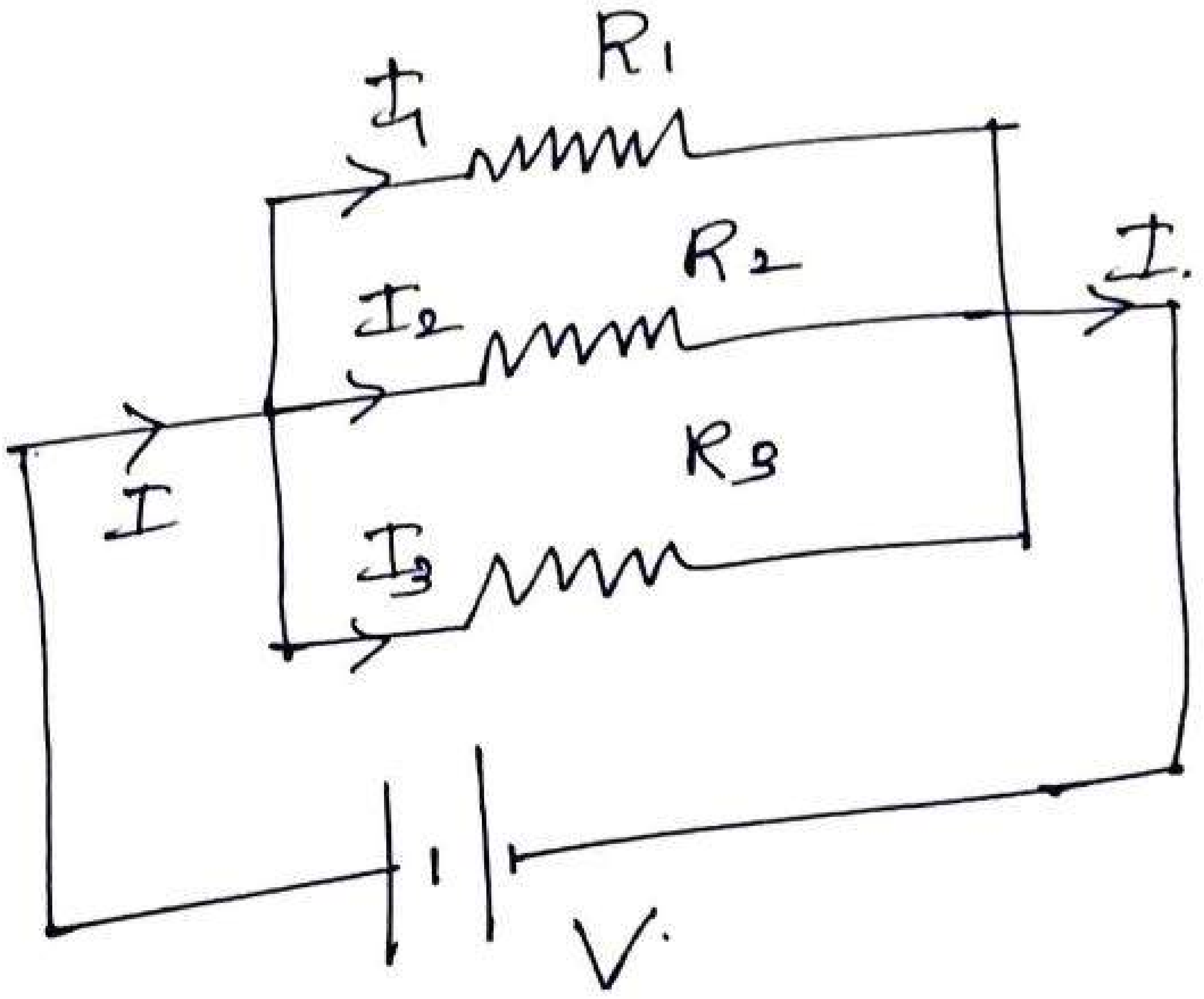


Fig. shows 3 resistors R_1, R_2 & R_3 connected in parallel, with currts. I_1, I_2 & I_3 flowing through them; and with voltage of V applied across them.

Now, $I = I_1 + I_2 + I_3$

Accdg to ohm's law,

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}.$$

where R is the eqt. resist. of the ckt.

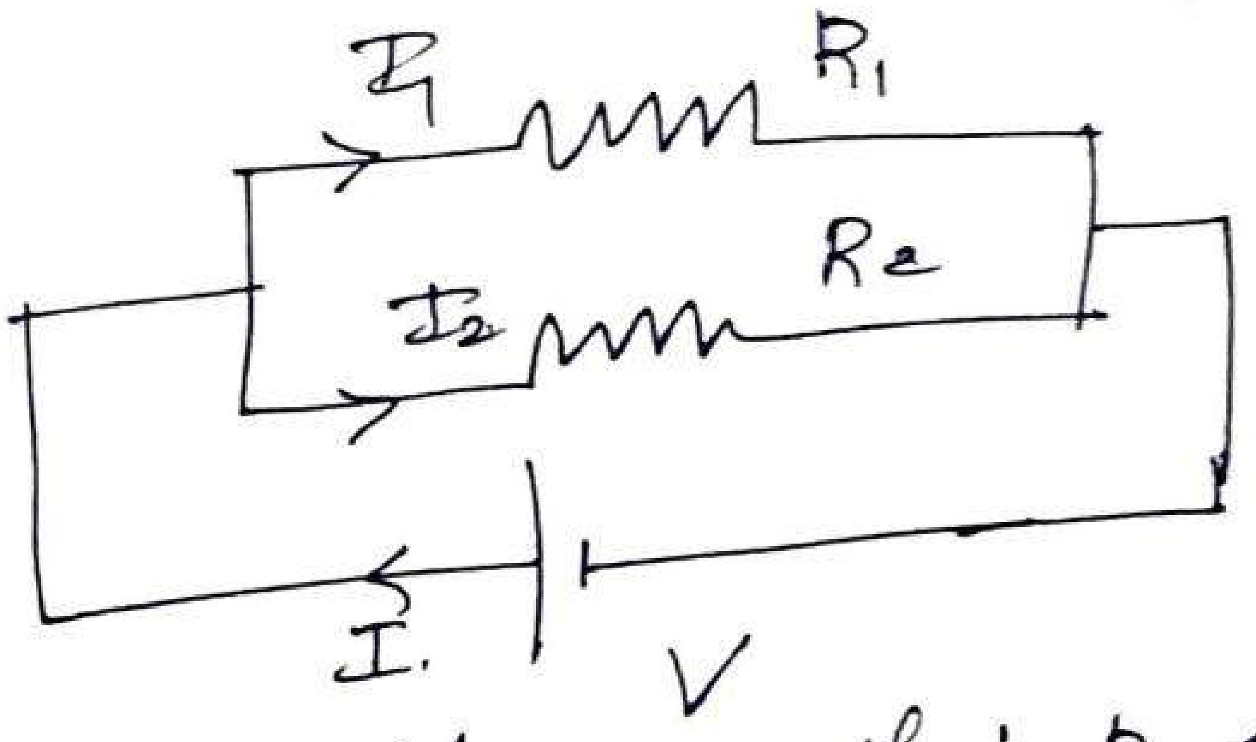
$$\therefore \boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}.}$$

* when no. of resistors are connected in parallel,

∴ The reciprocal of the total resistance = sum of the reciprocals of the individual resistances.

Division of current in a parallel ckt:

Consider two resistors R_1 & R_2 in parallel across a voltage source of V volts as shown in fig.



I_1 & I_2 are the currts. flowing thr' R_1 & R_2 resply. and I is the total current in the ckt.

we have, $I_1 = \frac{V}{R_1}$.

$$I_2 = \frac{V}{R_2}.$$

$$\frac{I_1}{I_2} = \frac{\frac{V}{R_1}}{\frac{V}{R_2}} = \frac{R_2}{R_1}.$$

But $I_2 = I - I_1$.

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}.$$

$$\frac{I_1}{I - I_1} = \frac{R_2}{R_1}$$

$$I_1 = \frac{R_2(I - I_1)}{R_1} \Rightarrow I_1R_1 = IR_2 - I_1R_2.$$

$$I_1(R_1 + R_2) = IR_2$$

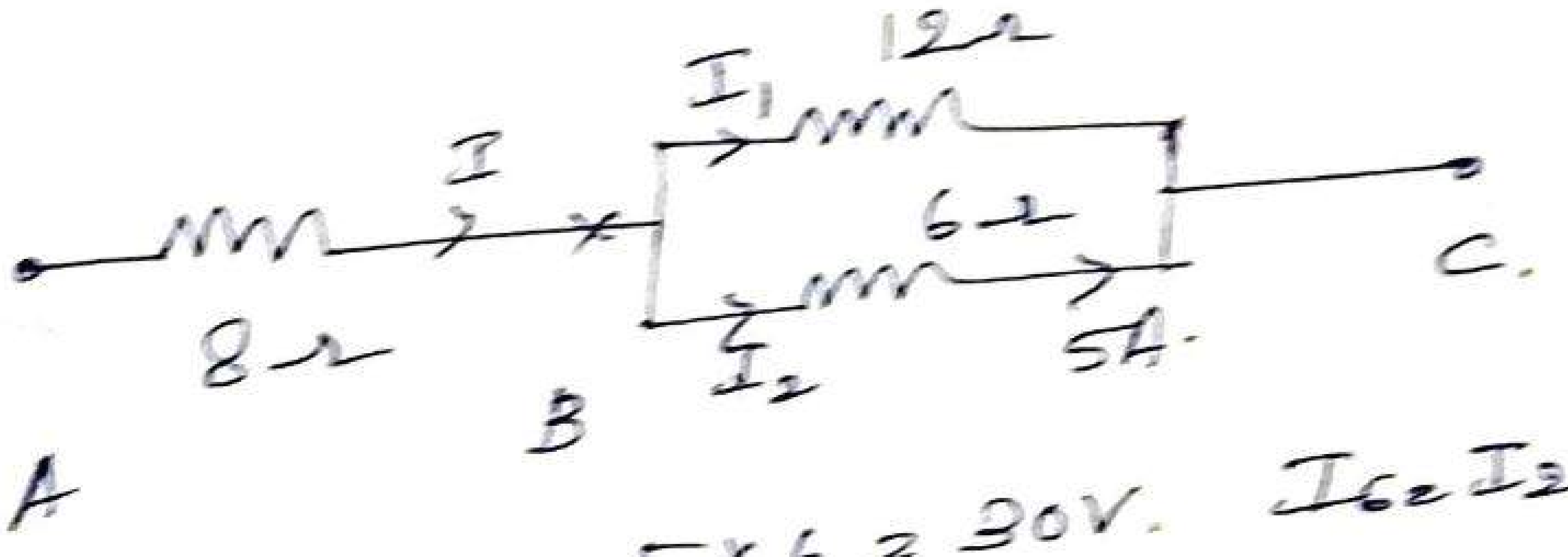
$$\therefore \boxed{I_1 = I\left(\frac{R_2}{R_1 + R_2}\right)}$$

Scanned by TapScanner

③

Jan09

① A 8Ω resistor is in series with a parallel combination of two resistors 12Ω and 6Ω. If the current in the 6Ω resistor is 5A, determ. the ~~total~~ power dissipated in the ~~circuit~~ ckt. (6m).



$I_6 = I_2 = 5A$

$V_{BC} = I_6 \times 6Ω = 5\times 6 = 30V.$

$I_{12} = I_1 = \frac{15}{6} A$

$\therefore\ I_{12} = \frac{V_{BC}}{12} = \frac{30}{12} = \frac{15}{6} = 2.5A$

$\therefore\ I = I_1 + I_2 = 5 + \frac{15}{6} = \frac{30+15}{6} = \frac{45}{6} = \underline{\underline{7.5A}}$

$\therefore$ Total power dissipated $= P_8 + P_{12} + P_6$

$= I^2\times 8 + I_1^2\times 12 + I_2^2\times 6.$

$= 7.5^2\times 8 + 25\times 12 + 2.5^2\times 6.$

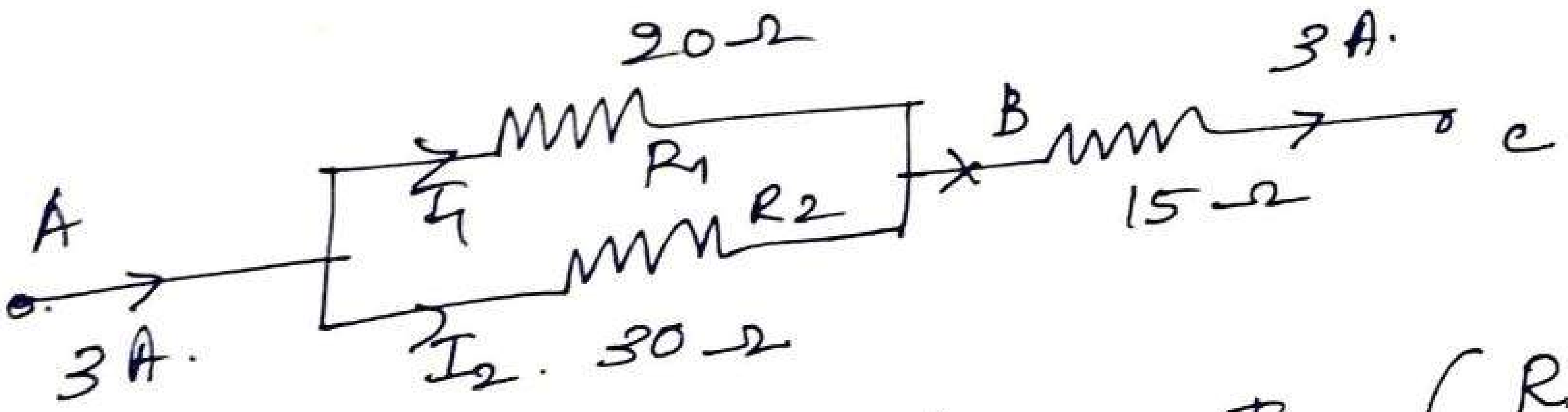
$= 450 + 300 + 37.5$

$P. =$ ~~787.5w~~ $\underline{675w}$

Jul07

②. A ckt consists of two parallel resistors having resist of 20Ω and 30Ω resp^ly connected in series with 15Ω. If current through 15Ω resistor is 3A, Find

Find (i) curret in 20Ω and 30Ω resistors ② the voltage across the whole ckt. ③ the total power and power consumed in all resistances (8m)



① Curret the' 20Ω resistor = $I_1 = \left(\frac{R_2}{R_1+R_2}\right) I$

$I_1 = 3 \times \frac{30}{50} = 1.8 A$

$I_2 = 3 \times \frac{20}{50} = 1.2 A$

② Voltage a/s the whole ckt = $V_{AB} + V_{BC}$

$= 20 \times 1.8 + 3 \times 15 = \underline{81 V}$

or. $R_t = (20 \| 30) + 15 = 27 \Omega$. ∴ $V_{AC} = 27 \times 3 = \underline{81 V}$

③ Power consumed in 15Ω, $P_{15} = I^2 \times 3$

$= 15 \times 3^2 = \underline{135 W}$

Power consumed in 20Ω = $P_{20} = I_1^2 \times 20$

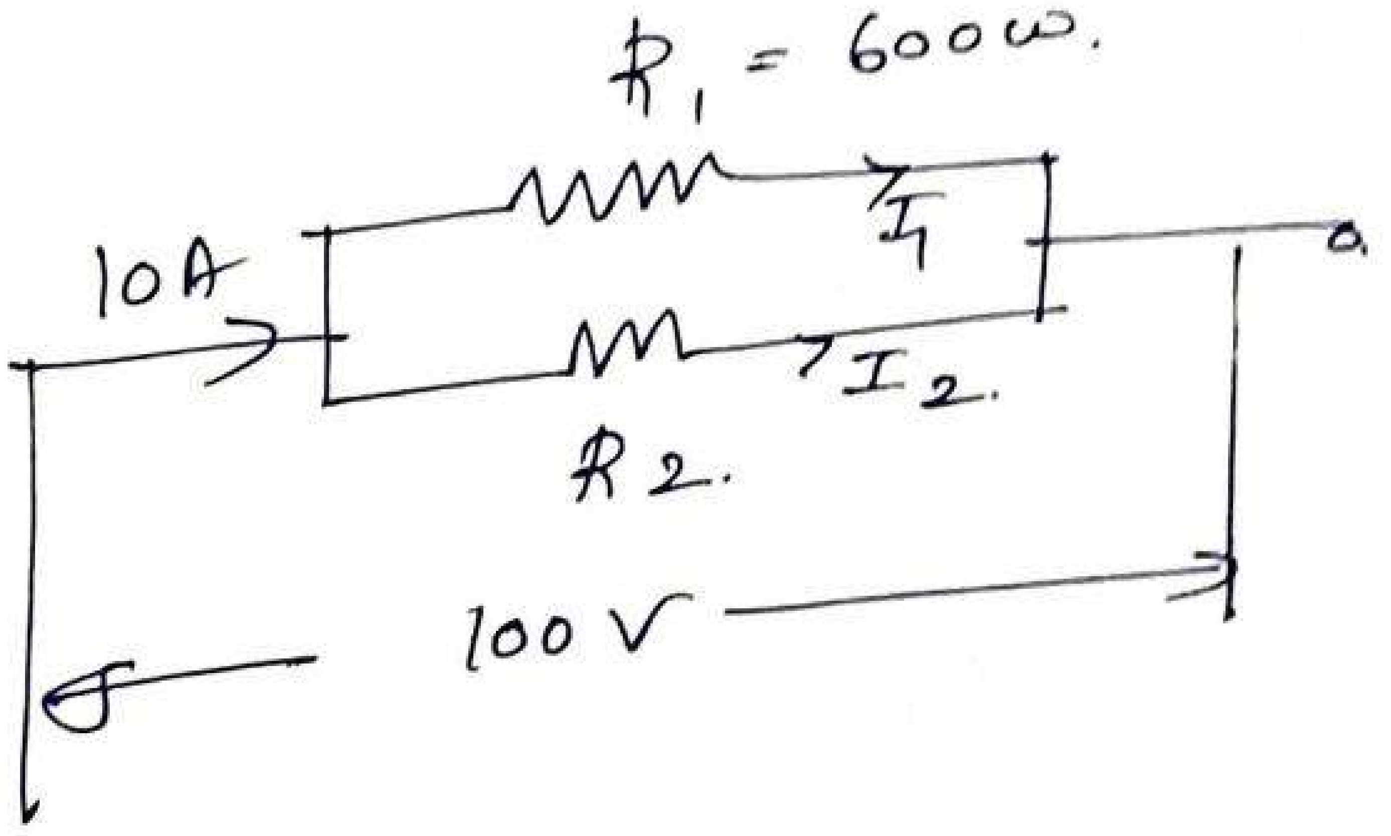
$= 1.8^2 \times 20 = \underline{64.8 W}$

Power consumed in 30Ω = $P_{30} = I_2^2 \times 30$

$= 1.2^2 \times 30 = \underline{43.2 W}$

∴ Total power = $P_{15} + P_{20} + P_{30} = = \underline{243 W}$

③ Two resistors connected in parallel a/s 100v dc supply. take 10 A from the line. The power dissipated in one resistor is 600ω. what is the curnt. drawn when are connected in series across the same supply?



$R_{Total} = \frac{100}{10}$

$= 10Ω$

$I_1^2 R_1 = 600ω.$

power $P_1 = \frac{V^2}{R_1}$ $\therefore R_1 = \frac{100^2}{600} = ~~16.67Ω~~$

$\boxed{R_1. = 16.7Ω}$

$I_1 = \frac{V}{R_1} = \frac{100}{16.7} = 6A$

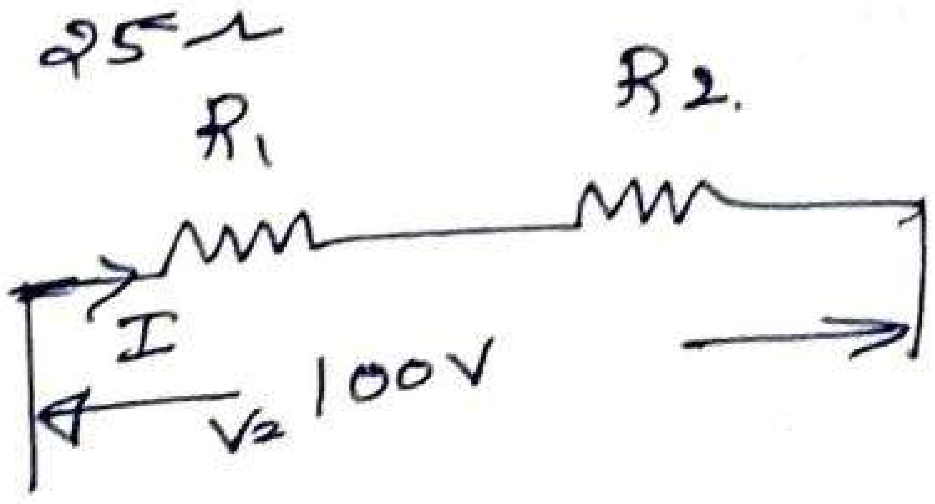
$\therefore I_2 = I - I_1 = 10-6 = 4A$

$R_2 = \frac{V}{I_2} = \frac{100}{4} = 25Ω$

$\boxed{R_2 = 25Ω}$

when connected in series

$R_1 = 16.7Ω$ $R_2 = 25Ω$



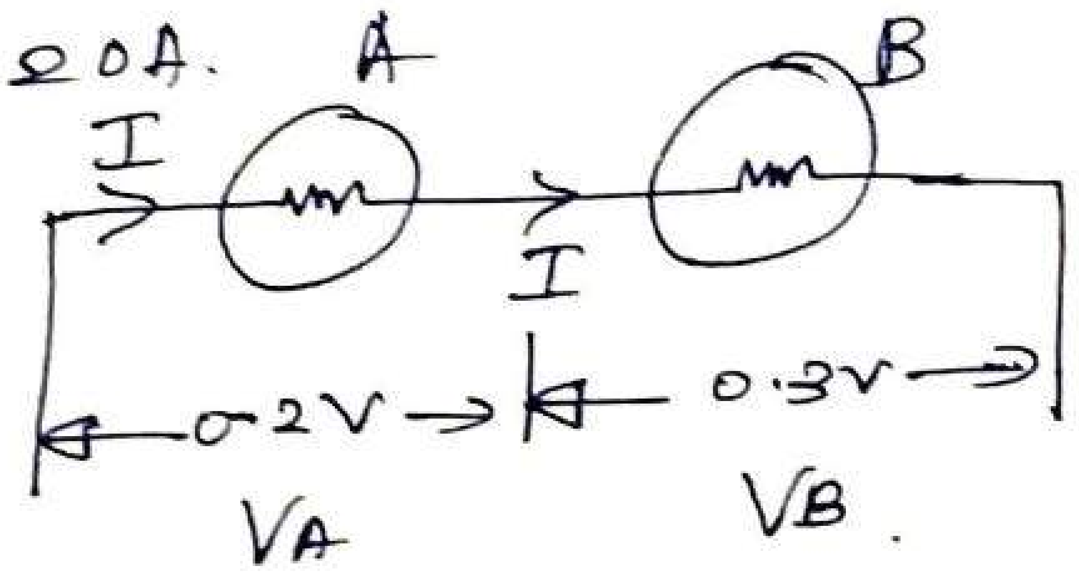
$I = \frac{V}{R_1+R_2} = \frac{100}{25+16.7}$

$\boxed{I = 2.39 A}$

④ Current of 20A flows through two ammeters A and B in series. The p.d. across A is 0.2V and across B is 0.3V. Find how the same current will divide between A and B when they are in parallel

Soln

ⓐ To find the resistances of ammeters A & B when in series



$I = I_A = 20A = I_B.$

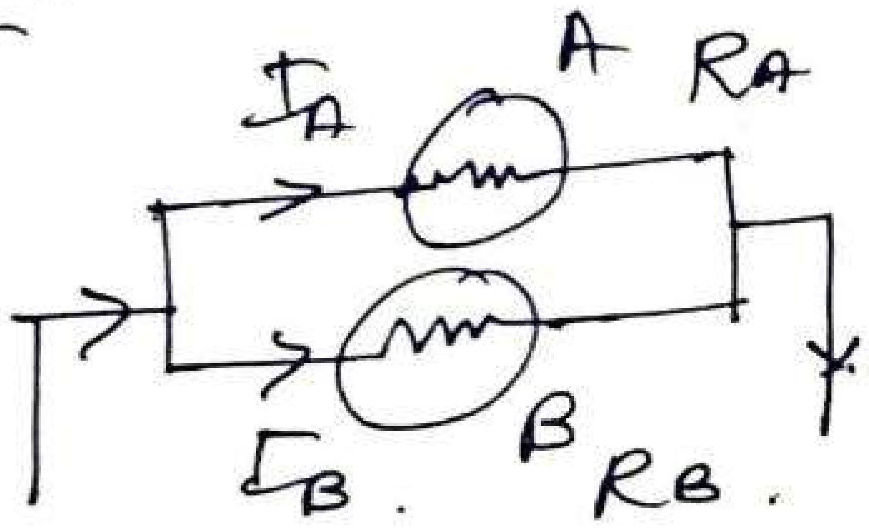
$V_A = 0.2V.$ $\quad V_B = 0.3V.$

$$R_A = \frac{V_A}{I_A} = \frac{0.2}{20} = 0.01\,\Omega$$

$$R_B = \frac{V_B}{I_B} = \frac{0.3}{20} = 0.015\,\Omega.$$

$$R_T = R_A + R_B = 0.01 + 0.015. = \underline{\underline{0.025\,\Omega}}$$

(b) when connected in parallel



$I = 20A.$ $\quad I_A = ?$ $\quad I_B = ?$

$$I_A = \left(\frac{R_B}{R_A + R_B}\right) I$$

$$I_A = 20\left(\frac{0.015}{0.025}\right) = \underline{\underline{12A}}$$

$$I_B = 20\left(\frac{0.01}{0.025}\right) = \underline{\underline{8A}} \quad = 20 - 12 = \underline{\underline{8A}}$$

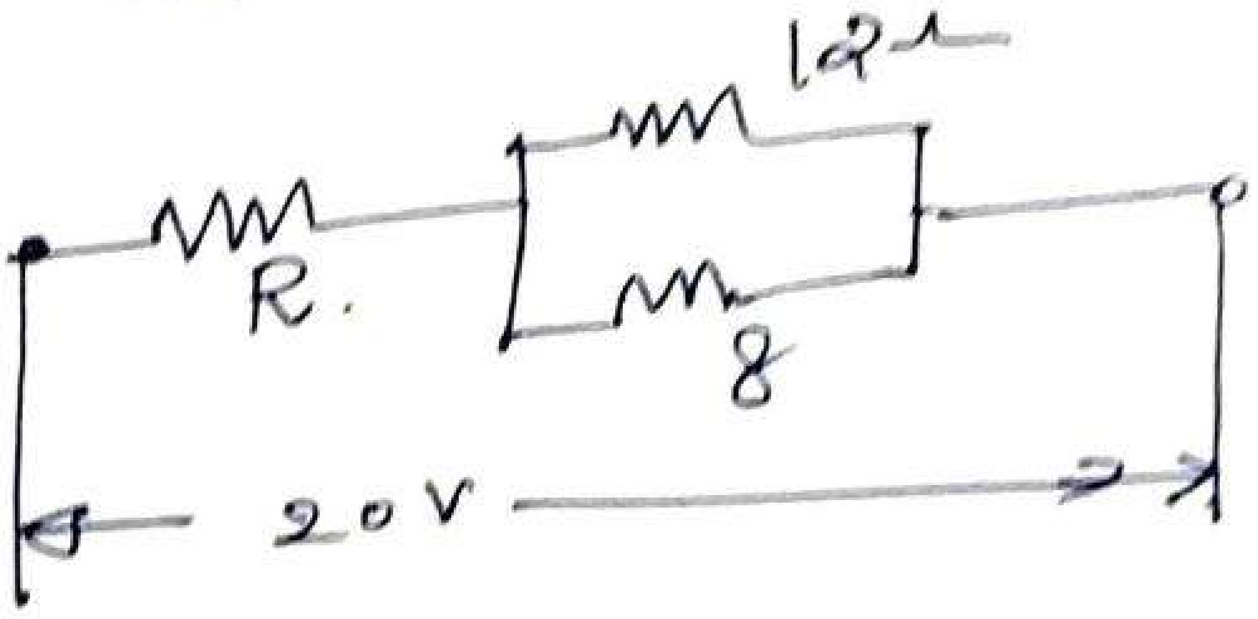
$$\therefore I = I_A + I_B = 12 + 8 = \underline{\underline{20A}}$$

IIIly, $I_2 = I\left(\frac{R_1}{R_1+R_2}\right)$

∴ Branch current = Main current. × $\frac{\text{other branch resist}}{\text{sum of the resists.}}$

(Jan10., 6m)

⑤ A resist R is connected in series with a parallel ckt comprising of two resists. of 12Ω and 8Ω respy. The total power dissipation in the ckts is 70w when the applied voltage is 20V. Calculate R.



Given. $P_T = 70W$.

$V = 20V$.

$$P = \frac{V^2}{R} \qquad P_T = \frac{V_T^2}{R_T}.$$

$$\therefore \quad R_T = \frac{V_T^2}{P_T} = \frac{20^2}{70} = \underline{\underline{5.71\Omega}}$$

$$R_T = R + \underset{\overset{\uparrow}{R_p}}{(12 \parallel 8)} = R + \frac{12\times8}{12+8}$$

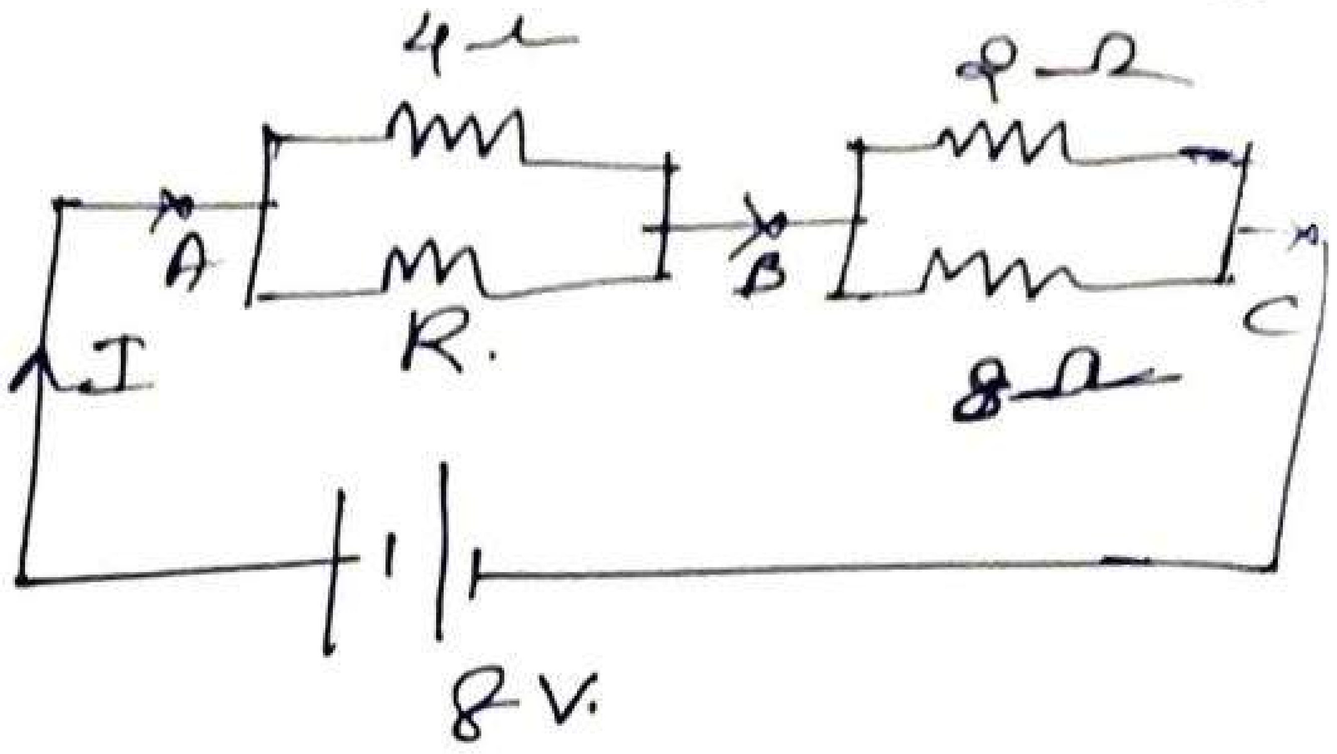
$$= \underline{\underline{R + 4.8\Omega}}$$

$$\therefore R = R_T - R_p. = 5.71 - 4.8 = \underline{\underline{0.91\Omega}}$$

$$\therefore \boxed{R = 0.91\Omega}$$

(may 10, 6m)

(6) The total power consumed by the n/w shown in fig is 16w. Find the value of R and the total curnt (6m)



soln

(1) $R_{AB} = \frac{4R}{4+R}$

$R_{BC} = \frac{2\times8}{2+8} = \frac{16}{10} = \underline{1.6\Omega}$

$\therefore R_T = R_{AB} + R_{BC}$

$R_T = 1.6 + \frac{4R}{4+R.}$ $P = \frac{V^2}{R.}$

$P_T = 16W.$ $V_T = 8V.$

$\therefore R_T = \frac{V_T^2}{P_T} = \frac{8^2}{16} \boxed{= \underline{4\Omega}}$

$\therefore 4\Omega = 1.6 + \frac{4R}{4+R.}$

$2.4 = \frac{4R}{4+R.}$

$(2.4\times4) + 2.4R = 4R.$

$9.6 = 1.6R.$

$R = \frac{9.6}{1.6} = \underline{6\Omega}$

$\boxed{R = 6\Omega}$

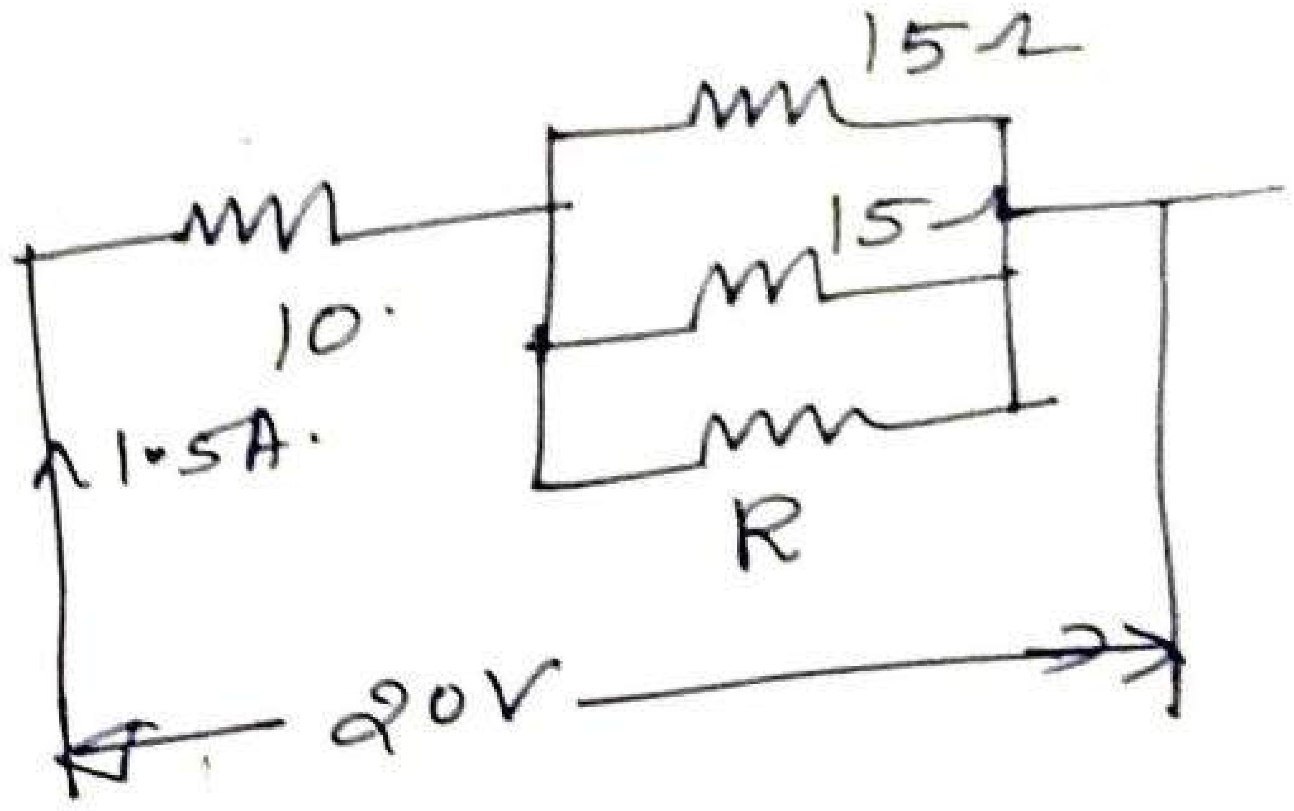
$R_T = 1.6 + \frac{4\times6}{4+6.}$
$= 1.6 + \frac{24}{10} = 4\Omega$

(2) $I = \frac{V_T}{R_T.} = \frac{8}{R_T}$

$\boxed{I = \frac{8}{4} = 2A}$

Hw.

(7) A resist of 10Ω is connected in series with two resists each of 15Ω arranged in parallel. ~~with~~ what resist must be shunted across the parallel combination so that the total current shall be 1.5A with 20V applied.



Soln

$$R_1 = \frac{15 \times 15}{15+15}$$

$$= \underline{\underline{7.5\Omega}}$$

$$R_T = 10 + \frac{7.5R}{7.5+R}.$$

$$I_T = \frac{V_T}{R_T} \Rightarrow \frac{20}{R_T} = 1.5A.$$

$$\therefore R_T = \frac{20}{1.5} = \underline{\underline{13.33}}\,\Omega.$$

$$13.33 = 10 + \frac{7.5R}{7.5+R}. \Rightarrow$$

$$3.33 = \frac{7.5R}{7.5+R}.$$

$$(3.33 \times 7.5) + (3.33R) = 7.5R.$$

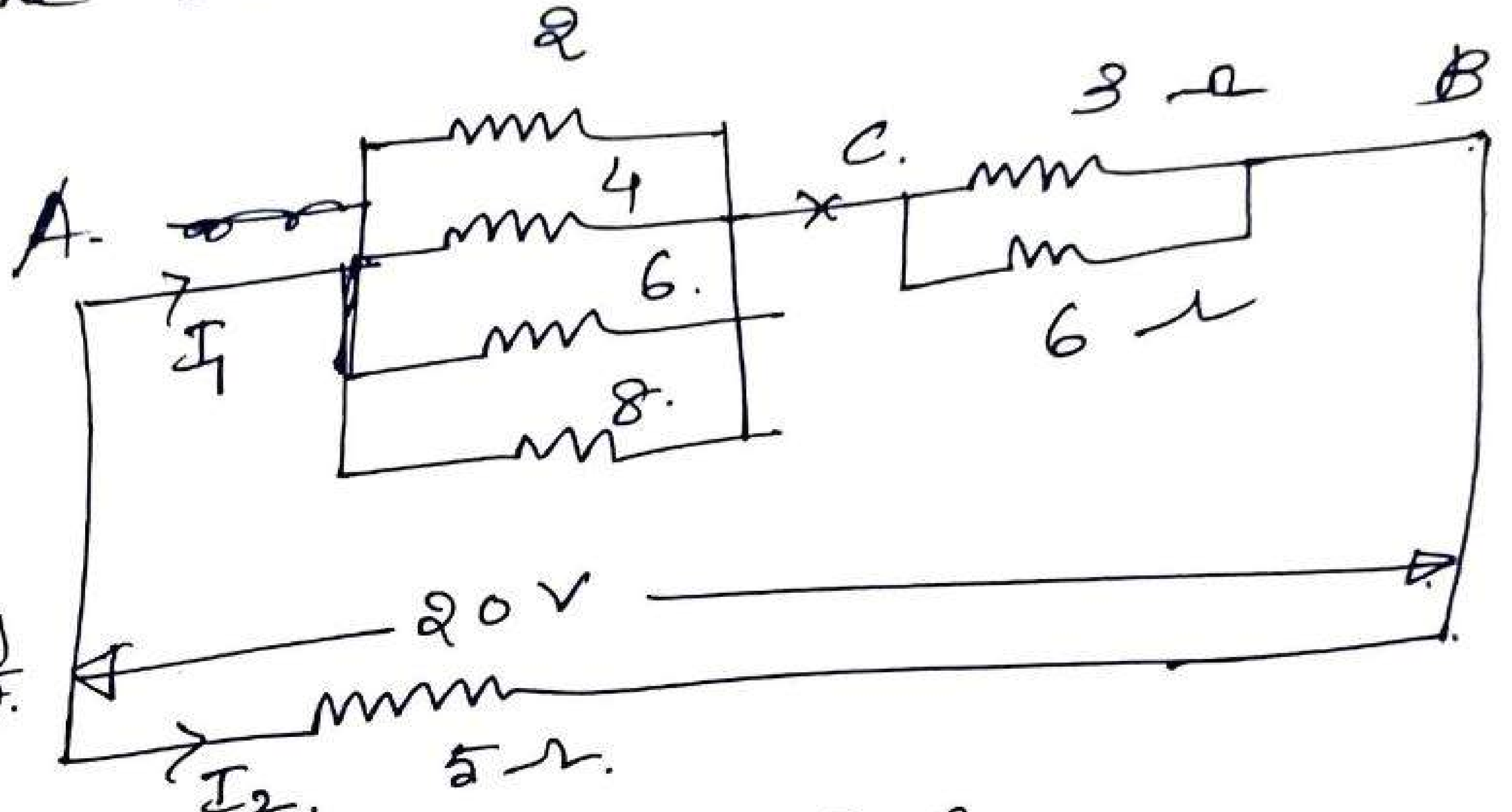
$$24.97 = 4.17R.$$

$$R = \frac{24.97}{4.17} = \underline{\underline{5.99\Omega}}$$

$$\approx 6\Omega$$

R

(8) If 20V is applied a/s AB as shown in fig: calculate the total current, the power dissipated in each resistor and the value of the series resist to halve the current.



Soln

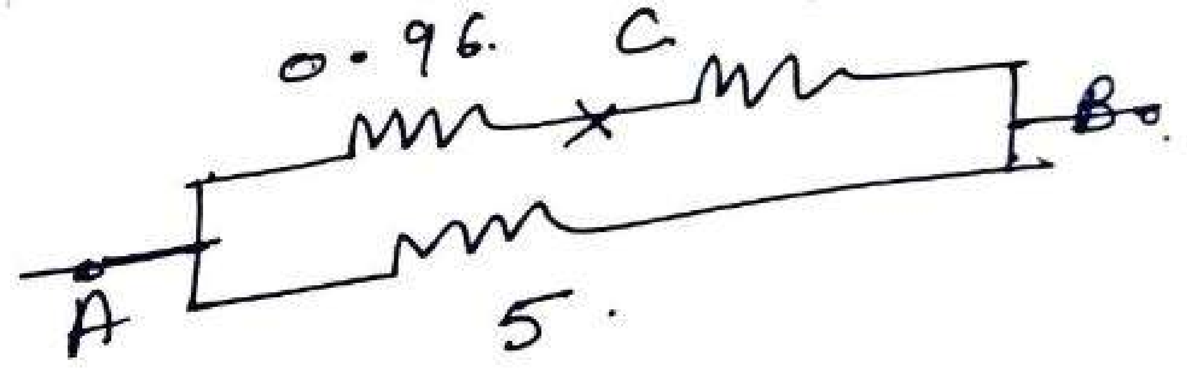
$R_{AC} = 2 \| 4 \| 6 \| 8$

$R_{AC} = 0.96\Omega$

$\frac{1}{R_{AC}} = \frac{1}{2} + \frac{1}{4} + \frac{1}{6} + \frac{1}{8}$

$\frac{1}{R_{CB}} = \frac{1}{3} + \frac{1}{6}$ $\quad R_{CB} = 2\Omega$

$R_{AB} = R_{AC} + R_{CB} = 0.96 + 2 = \underline{2.96\Omega}$



$\therefore R_T = (2.96) \| 5$

$R_T = \underline{1.86\Omega}$

$\therefore I = \frac{V_T}{R_T} = \frac{20}{1.86} = \boxed{10.76\ A}$

$I' = \frac{20}{1.86 + 1.86}$

Value of the series resistor = $\underline{\underline{1.86\Omega}}$ $\quad I' = \underline{\underline{5.376\ A}}$

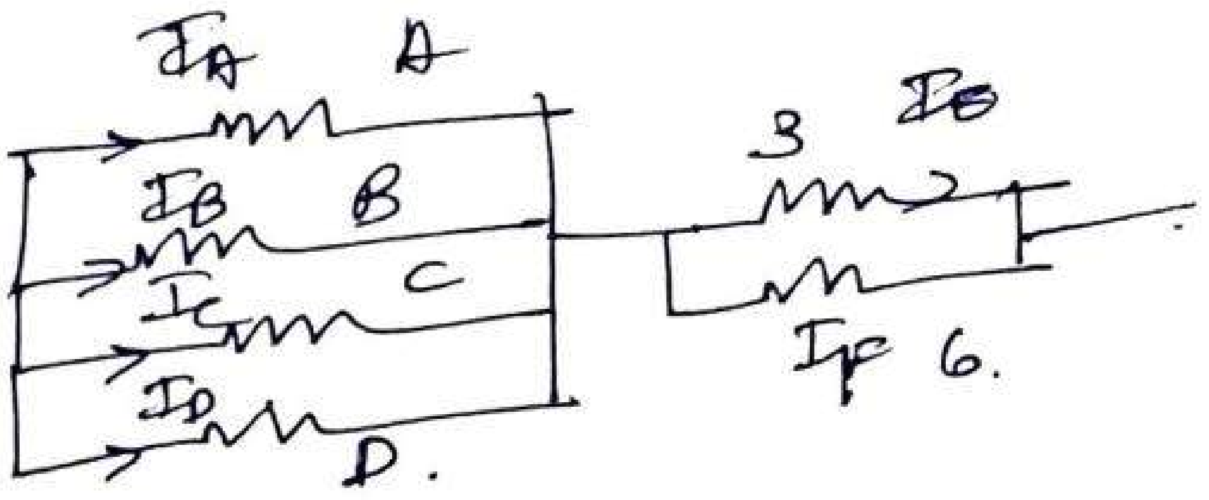
I_1 = current thr' ACB. $= \frac{I \times 5}{5 + 2.96} = \underline{\underline{6.79A}}$

$I_2 = \frac{10.81 \times 2.96}{7.96} = \underline{\underline{4.019A}}$

$V_{CB} = I_1 R_{CB} = 13.56V.$

$V_{AC} = 0.96 \times 6.71 = \underline{\underline{6.441V}}$

$I_A = \frac{V_{AC}}{R_A} = 2.25\ A$ $\quad I_A^2 R_A = \underline{\underline{21.125\omega}}$



$I_B = \frac{V_{AC}}{R_B} = \frac{6.51}{4} = 1.63A$

$P_B = I_B^2 R_B = 1.63^2 \times 4$
$= 10.63\ \omega$

$P_C = 1.085^2 \times 6 = 6.99\ \omega$

$I_C = \frac{V_{AC}}{R_C} = 1.085A.$

$P_D = 0.814^2 \times 8 = 5.3\ \omega$

$I_D = \frac{V_{AC}}{R_D} = 0.814\ A$

$P_E = 2.26^2 \times 3 = 2\ 15.3w$

$I_E = \frac{V_{CB}}{3} = 2.26A$

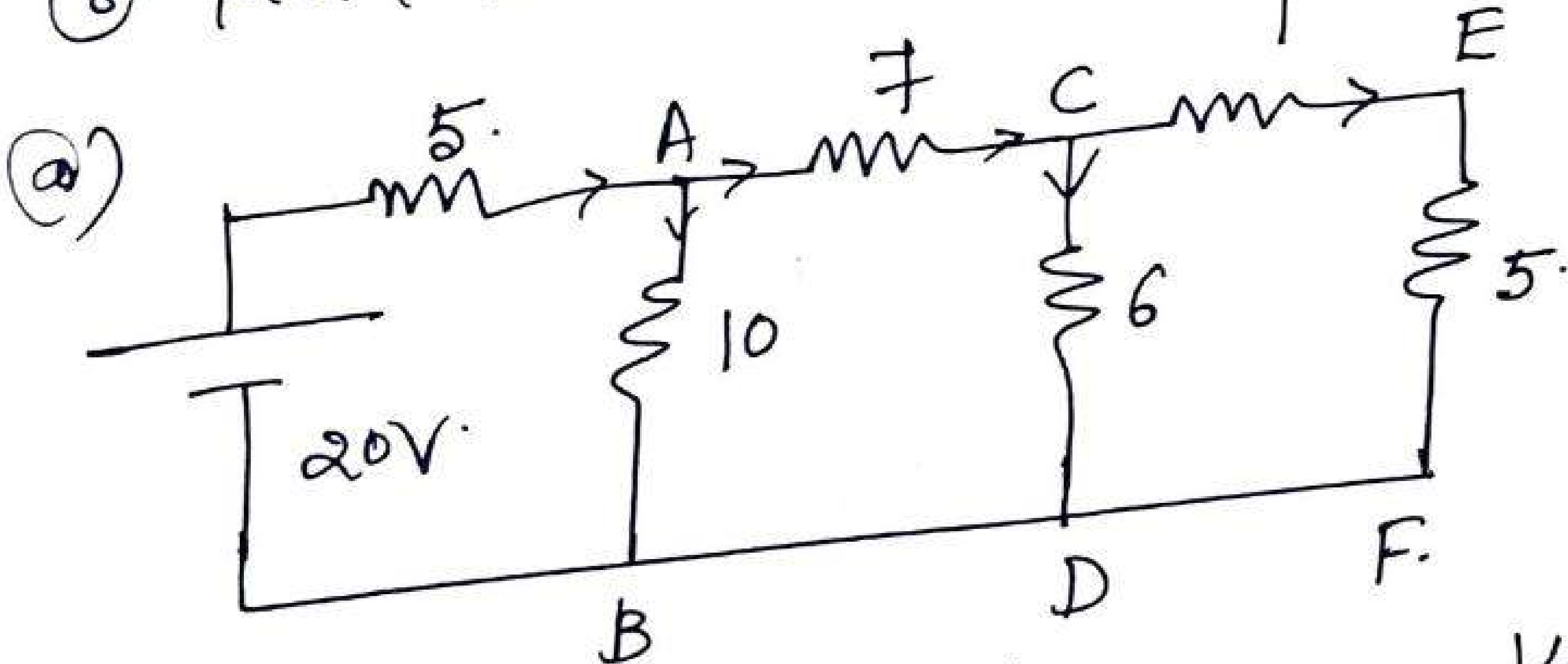
$P_F = 4.5^2 \times 6 = 121.5\ \omega$

$I_F = \frac{V_{CB}}{6} = 4.5A.$

$P_T = ~~P_A~~ + P_B + P_C + P_D + P_E + P_F =.$

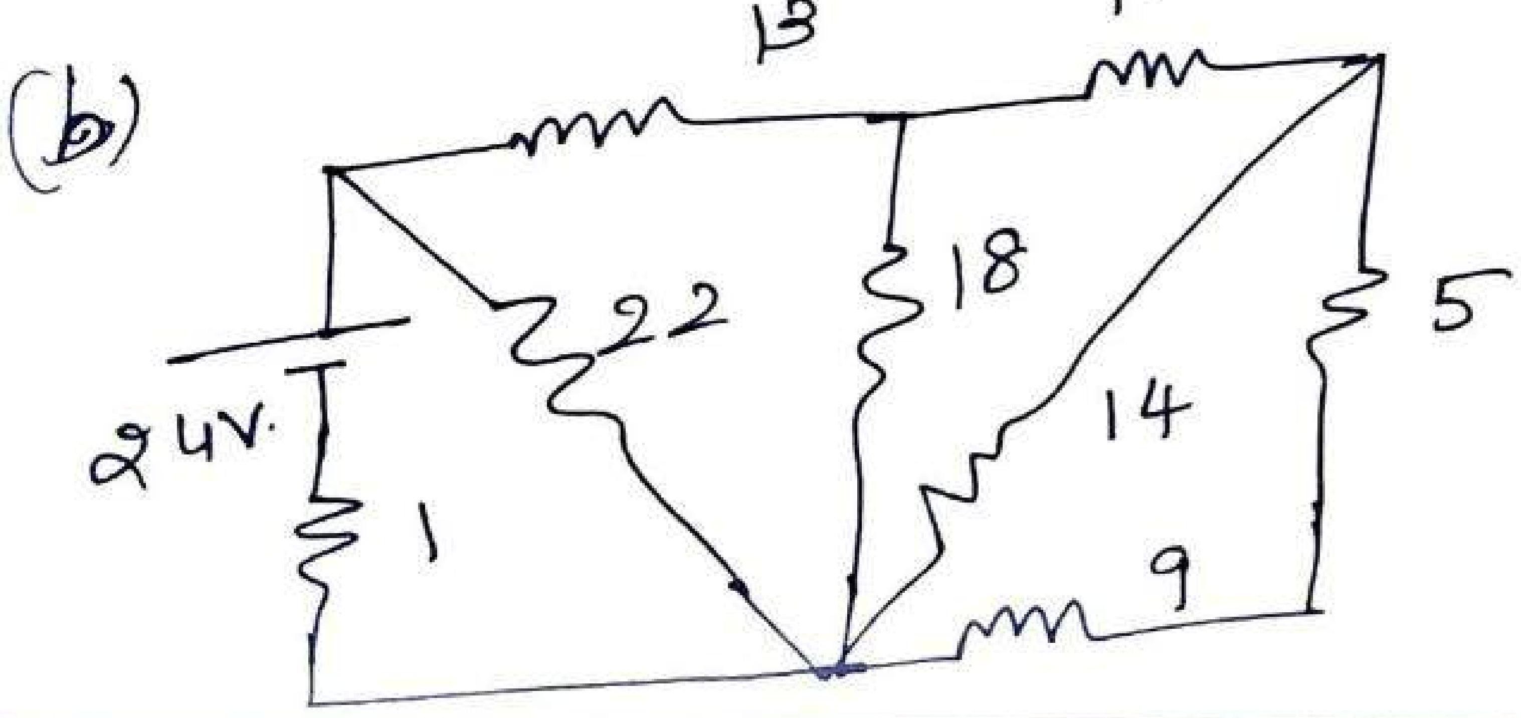
HW
⑧ Find the curret supplied by the battery. in fig.

(a)



$6 \| 6 = 3\Omega$
$10 \| 10 = 5\Omega$
$5 + 5 = 10\Omega$
$I = \frac{20}{10} = 2A$

(b)



$14 \| 14 = 7\Omega$
$18 \| 18 = 9\Omega.$
$22 \| 22 = 11\Omega.$
$11 + 1 = 12\Omega$
$I = \frac{24}{12} = 2A$

KIRCHOFF's LAWS.

Kirchoff's laws are more comprehensive than ohm's law and are used for solving electrical n/ws which may not be readily solved by the ohm's law. The two laws are: (1) kirchoff's current law (KCL) or point law

(2) Kirchoff's voltage law. (KVL)

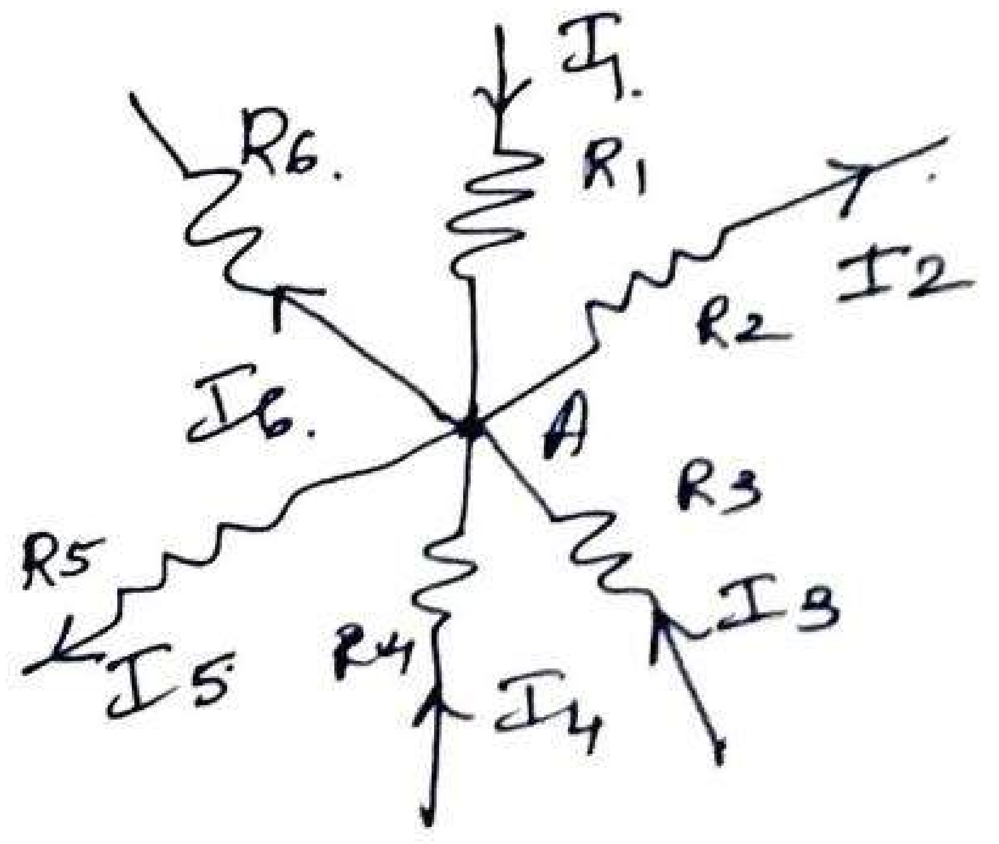
Kirchoff's current Law (KCL) (point law)

Statement: - It states that in any electrical n/w the algebraic sum of the currents meeting at a junction or point is zero.

i.e The total current entering a junction = Total current leaving the junction,

Explanation

Consider a few conductors meeting at a point A as shown in fig.



Assuming the incoming currents to be +ve and the outgoing currents as -ve, the KCL applied at A gives,

$$I_1 - I_2 + I_3 + I_4 - I_5 = I_6 = 0.$$

$$I_1 + I_3 + I_4 = I_2 + I_5 + I_6$$

Sum of Incoming currents = Sum of outgoing currents

Kirchoff's voltage Law (KVL)

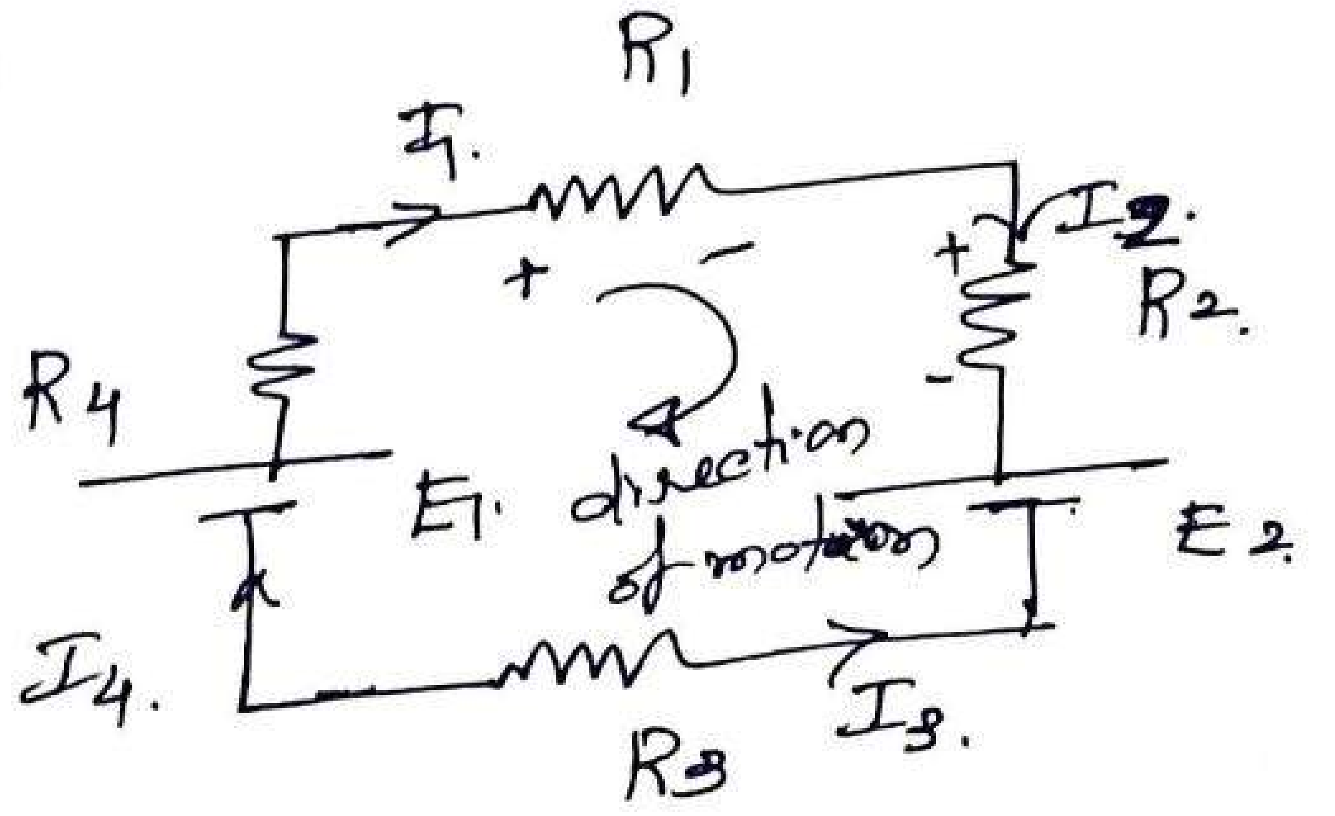
Statement: The algebraic sum of the product of currents and resistances in each of the conductors in a closed path in a n/w plus the algebraic sum of the emfs in that path is zero.

i.e. $\Sigma IR + \Sigma$ E.mfs $= 0$. in the closed path.

Explanation

Consider the following mesh with resists. & sources as shown.

Rise in voltage is taken +ve and fall in voltage is −ve.



Applying KVL to the above mesh,

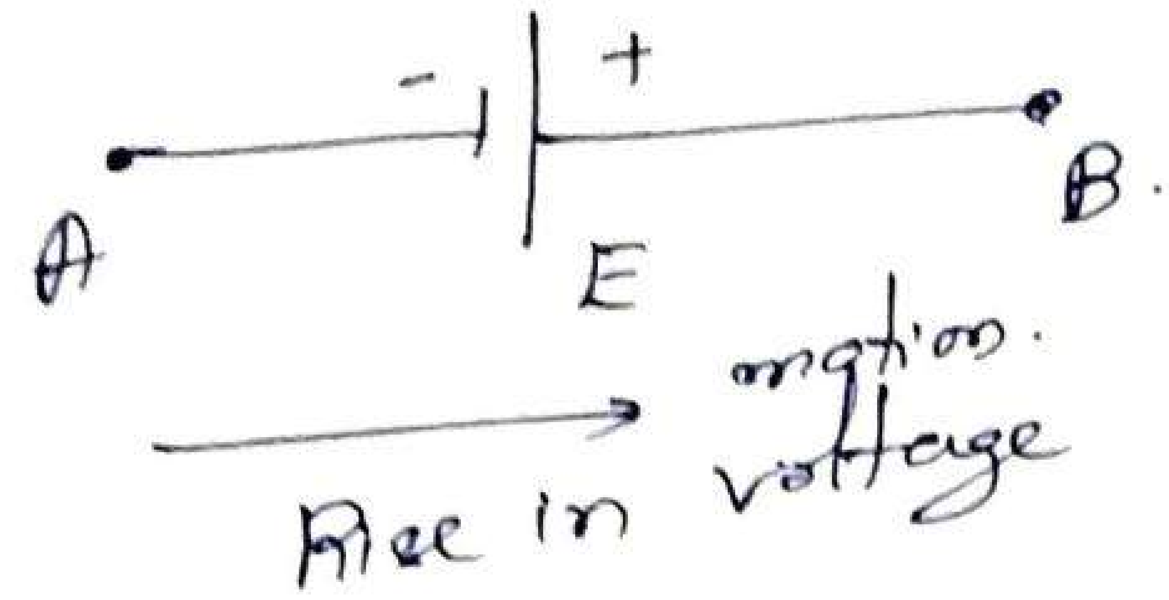
$$E_1 - I_4R_4 - I_1R_1 - I_2R_2 - E_2 + I_3R_3 = 0.$$

$$E_1 - E_2 = I_1R_1 + I_2R_2 - I_3R_3 + I_4R_4 = 0.$$

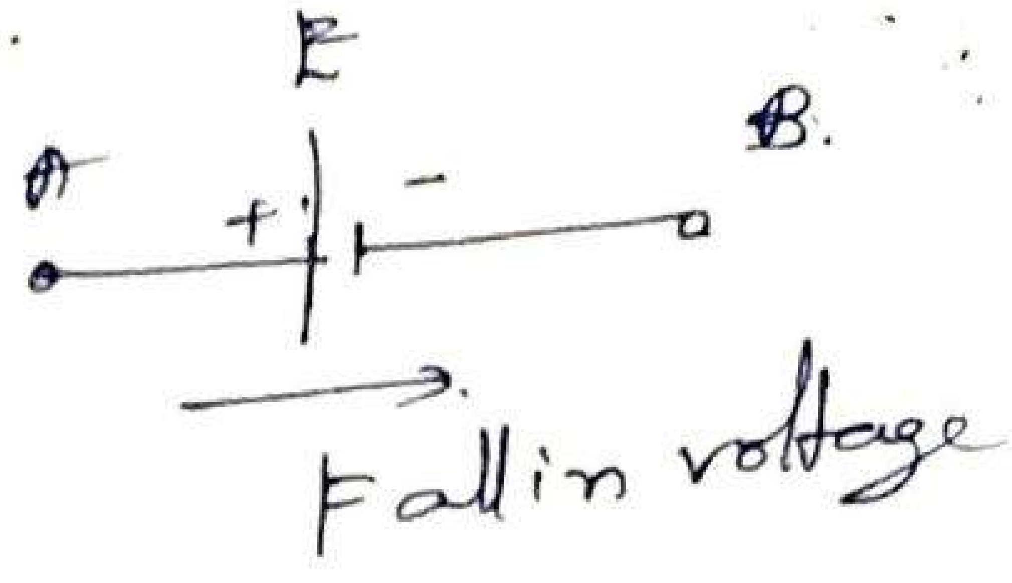
Note: Sign of battery emf

A rise in voltage is +ve and fall in voltage has −ve sign.

As we go from the −ve terminal to the +ve terminal of the battery, there is a rise in potential. Hence, in the follg fig,(a) +E = VAB.



$V_{AB} = +E$. Fig (a)



$V_{AB} = -E$.
Fig (b)

In fig (b), we go from the +ve to -ve terminal

∴ $V_{AB} = -E$.

The sign of the battery emf is independent of the direction of current through that branch.

(ii) <u>Sign of IR drop.</u>

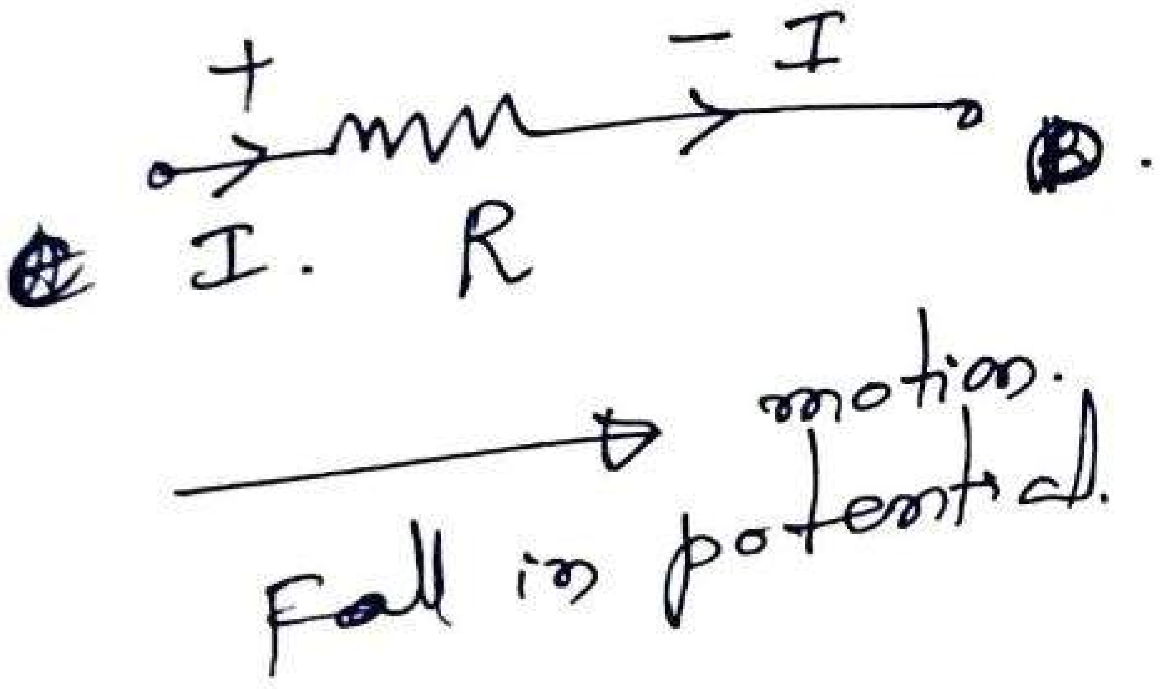


Fig (c)

$V_{CD} = -IR$.

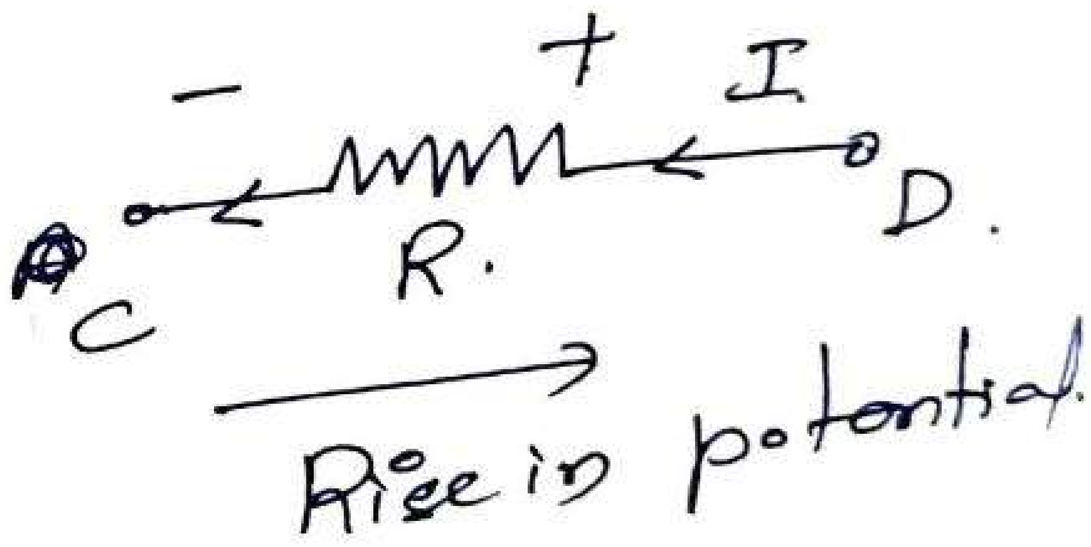


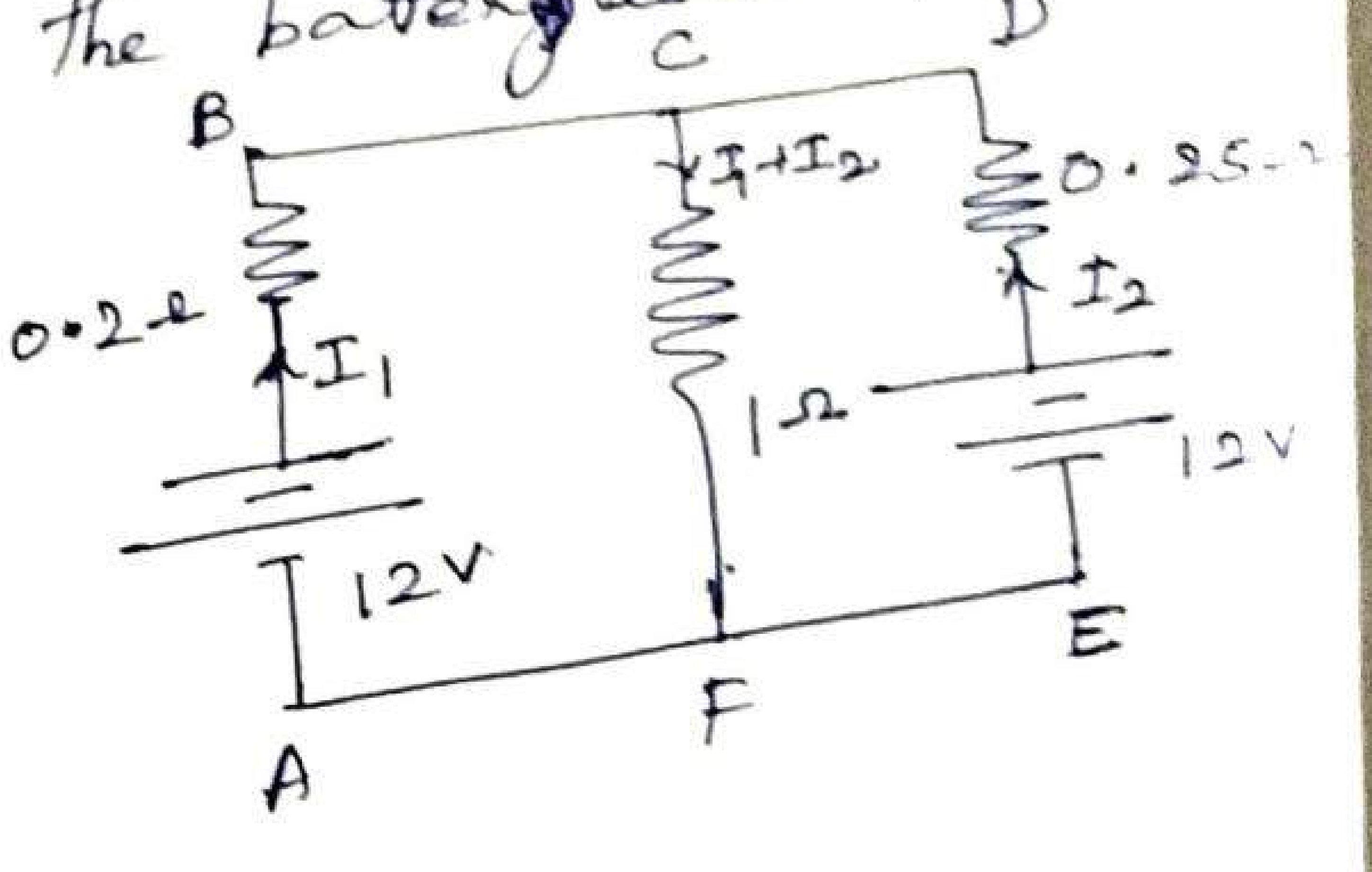
Fig (d)

$V_{CD} = +IR$.

If we go in a direction same as that of the currt. through the resistor, then there is a fall in potential as in fig (c), because currt. flows from higher to lower potential. $V_{CD} = -IR$.
|||ly, if we go in a dirn. opposite to that of currt. IR drop is +ve. In fig (d) $V_{CD} = +IR$.

Dec '11

(1) Two 12V batteries with internal resists 0·2Ω and 0·25Ω resply are joined in parallel and a resist of 1Ω is placed across the terminals. Find the currents supplied by the batteries and power dissipated in 1Ω resistor.



Soln Let I_1 & I_2 be the currents supplied by the batteries.

Applying KVL to loop ABCFA,

$$12 - 0.2 I_1 - 1(I_1+I_2) = 0.$$

$$-1.2 I_1 - 1 I_2 = -12.$$

$$1.2 I_1 + I_2 = 12. \quad — (1)$$

Apply KVL to loop CDEFC.

$$+0.25 I_2 - 12 + (I_1+I_2)(1) = 0.$$

$$I_1 + 1.25 I_2 = 12 - \quad ②$$

(2) ×1.2, $1.2 I_1 + 1.5 I_2 = 14.4. \quad —(3)$

(3) − (1), gives, $(1.5-1) I_2 = 14.4 - 12$

$$0.5 I_2 = 2.4 \quad \boxed{I_2 = 4.8A}$$

Subst I_2 value in (2).

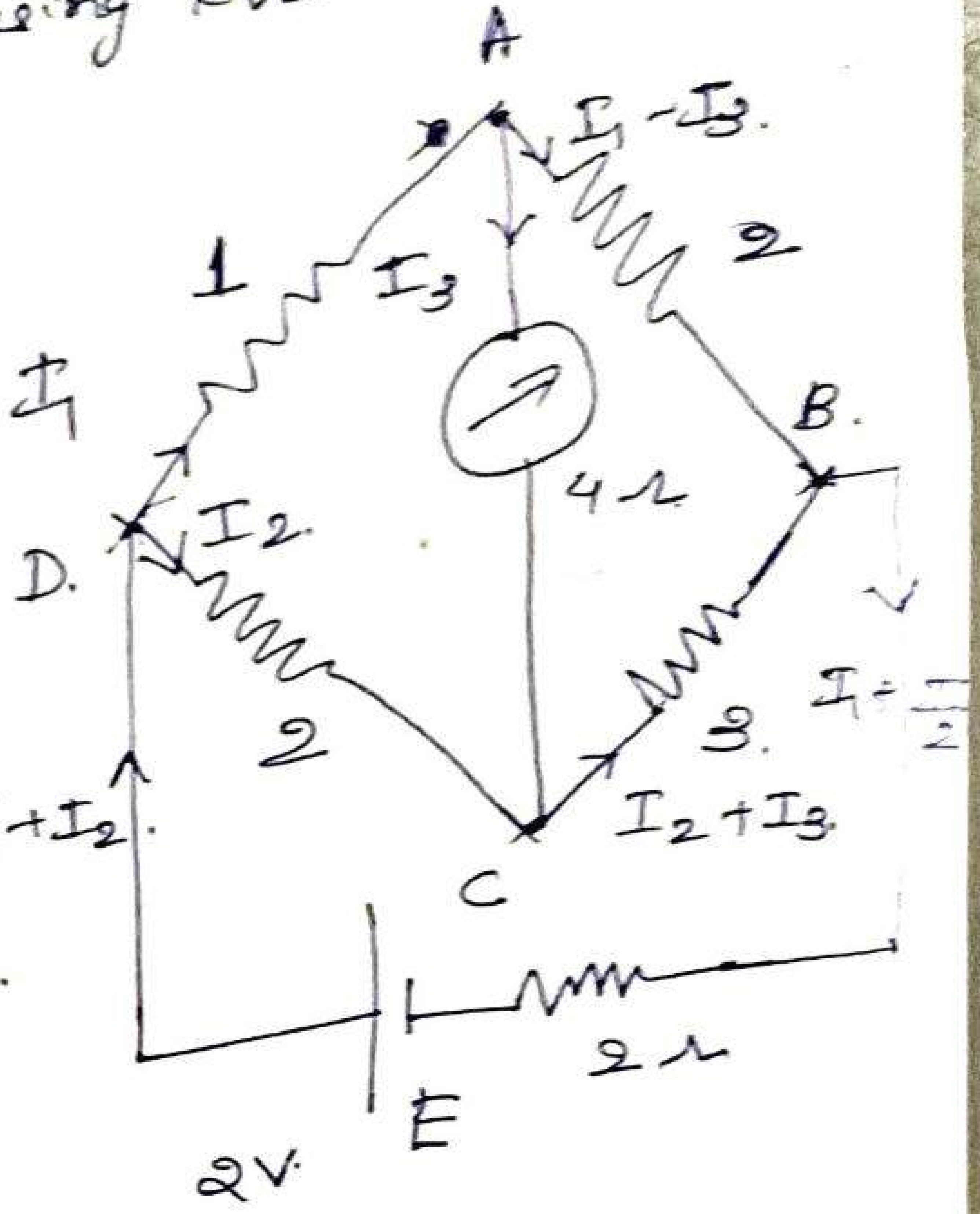
$$I_1 = 12 - 1.25 I_2 = 12 - 1.25 \times 4.8$$

$$\boxed{I_1 = 6 \text{ Amps}}$$

Currt. thru' 1Ω = $I_1 + I_2$ = 10.8A

Power = $10.8^2 \times 1 = 116.64W$

② Determine the current in the unbalanced bridge ckt. shown in fig. using KVL.



Applying KVL to loop DACD.

$$-I_1(1) - 4 I_3 + I_2(2) = 0.$$

$$I_1 - 2I_2 + 4 I_3 = 0. \quad — ①$$

KVL For loop ABCA.

$$-2(I_1 - I_3) + 3(I_2 + I_3) + 4 I_3 = 0.$$

$$-2I_1 + 3 I_2 + 9 I_3 = 0.$$

$$2 I_1 - 3I_2 - 9I_3 = 0 \quad — (2)$$

KVL for loop. DCBED.

$$-2I_2 - 3(I_2 + I_3) - 2(I_1 + I_2) + 2 = 0.$$

$$-2I_1 - 7I_2 - 3I_3 + 2 = 0.$$

$$2I_1 + 7I_2 + 3I_3 = 2. \quad — (3)$$

writing the eqns. (1), (2) & (3) in matrix form,

$$\begin{bmatrix} 1 & -2 & 4 \\ 2 & -3 & -9 \\ 2 & 7 & 3 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 1 & -2 & 4 \\ 2 & -3 & -9 \\ 2 & 7 & 3 \end{vmatrix} = 1(-9+63) + 2(6+18) + 4(14+6) = \underline{\underline{182}}$$

$$\Delta_1 = \begin{vmatrix} 0 & -2 & 4 \\ 0 & -3 & -9 \\ 2 & 7 & 3 \end{vmatrix} = 60 \Rightarrow 2(18+12)$$

$$\Delta_2 = \begin{vmatrix} 1 & 0 & 4 \\ 2 & 0 & -9 \\ 2 & 2 & 3 \end{vmatrix} = 1(18) + 4(4) = \underline{\underline{34}}$$

$$\Delta_3 = \begin{vmatrix} 1 & -2 & 0 \\ 2 & -3 & 0 \\ 2 & 7 & 2 \end{vmatrix} = 1(-6) + 2(4) = \underline{\underline{2}}$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{60}{182} = \underline{\underline{0.329\,A}}$$

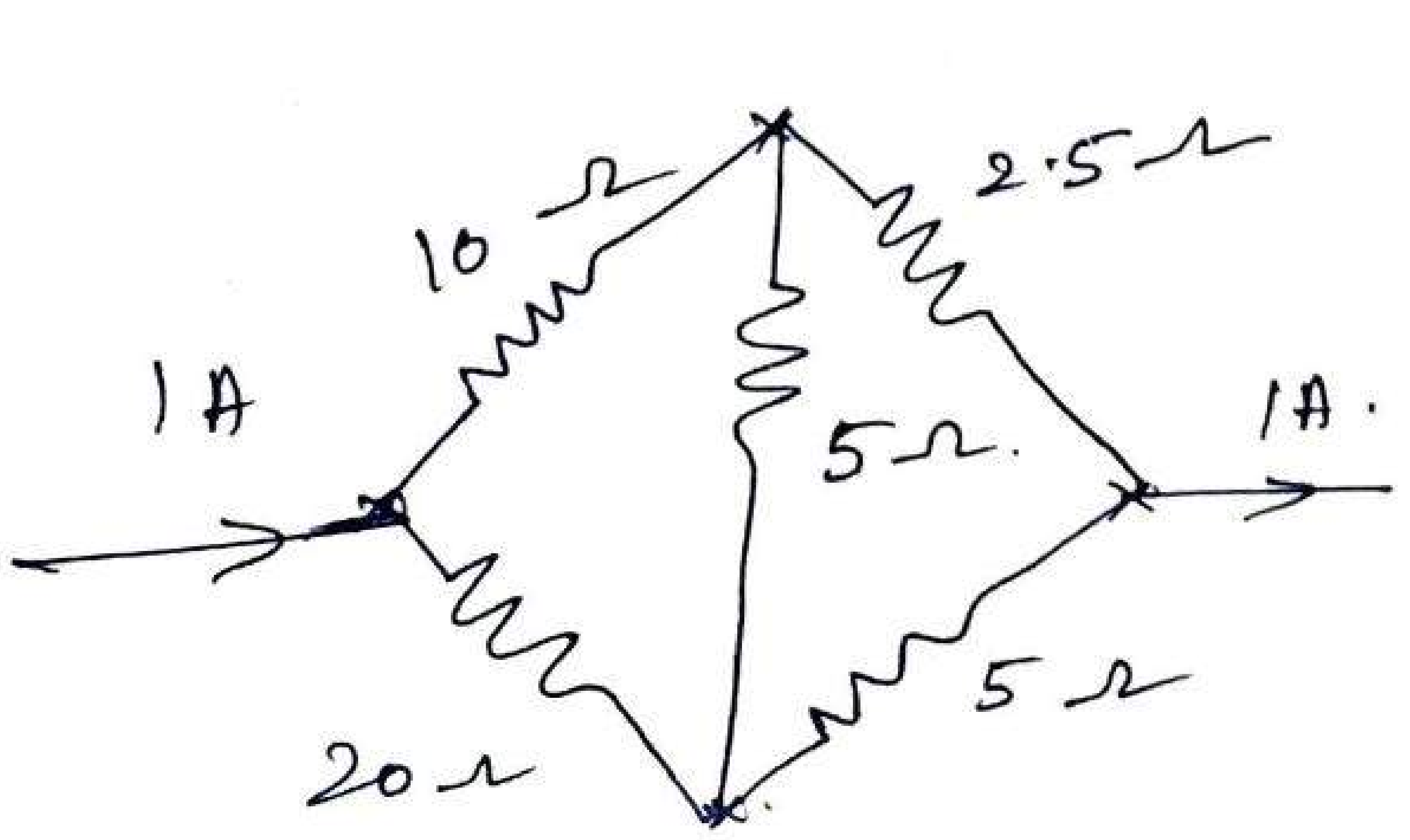
$$I_2 = \frac{\Delta_2}{\Delta} = \frac{34}{182} = \underline{\underline{0.186\,A}}$$

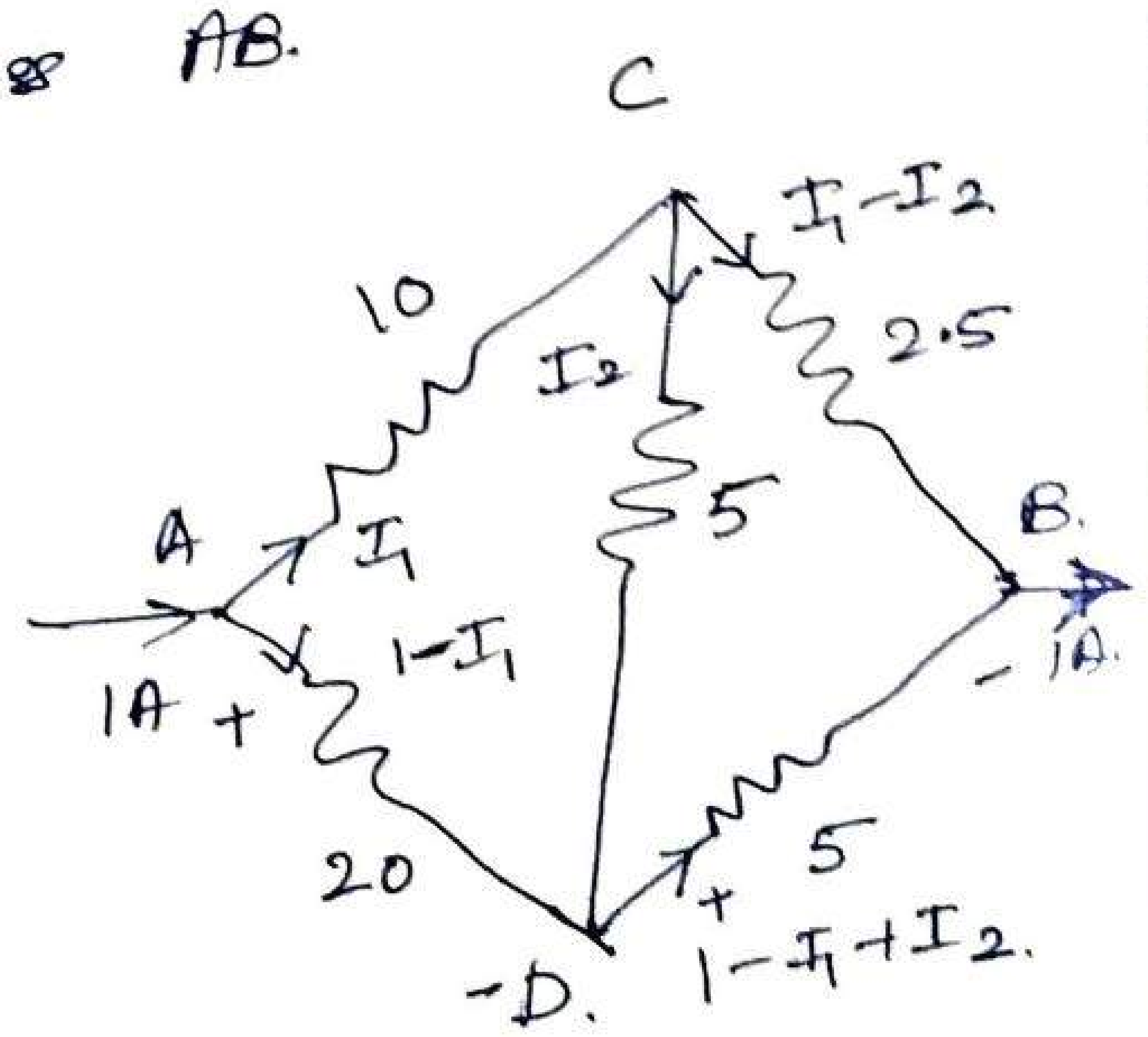
$$I_3 = \frac{\Delta_3}{\Delta} = \frac{2}{182} = \underline{\underline{0.010\,A}}$$

∴ Current in the unbalanced branch $I_3 = \underline{0.010A}$ in the direction shown.

(Aug 08; 6m)

③ Find the currents in all the resistors of the n/w shown. Also find the voltage across AB.





(1) currents the branches

The current distribution in various branches are as shown.

Apply KVL for loop ACDA.

$-10I_1 - 5I_2 + 20(1 - I_1) = 0.$

$-30I_1 - 5I_2 = -20.$ $\quad 30I_1 + 5I_2 = 20.$ — ①

KVL for loop CBDC,

$-2.5(I_1 - I_2) + 5(1 - I_1 + I_2) + 5I_2 = 0.$

$-7.5I_1 + 12.5I_2 + 5 = 0.$

$7.5I_1 - 12.5I_2 = 5$ — ②

Solving (1) & (2), $I_1 = 0.666A.$

$I_2 = 0A.$

Currents in branches

$AC \rightarrow I_{AC} = I_1 = 0.666A.$

$I_{CB} = I_1 - I_2 = 0.666A$

$I_{DB} = 1 - I_1 + I_2 = 1 - 0.666 + 0 = 0.333A$

$I_{AD} = 1 - I_1 = 1 - 0.666 = 0.333A.$

$I_{CD} = I_2 = 0.$

(2) The voltage across AB.

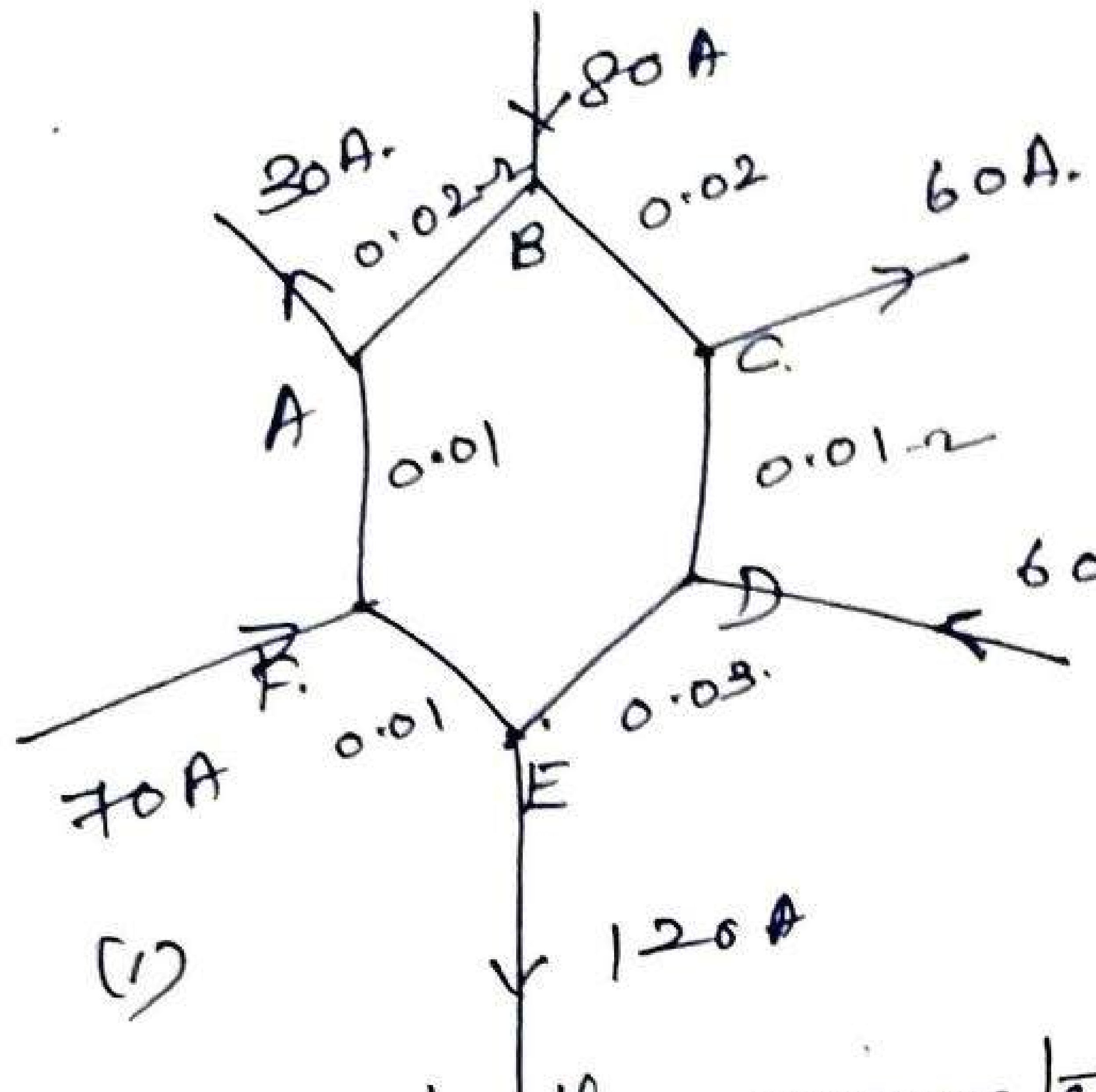
$V_{AB} =$ Start from B and traverse a path to A.

$V_{AB} = 5I_{DB} + 20I_{AD} = 5(0.333) + 20(0.333)$

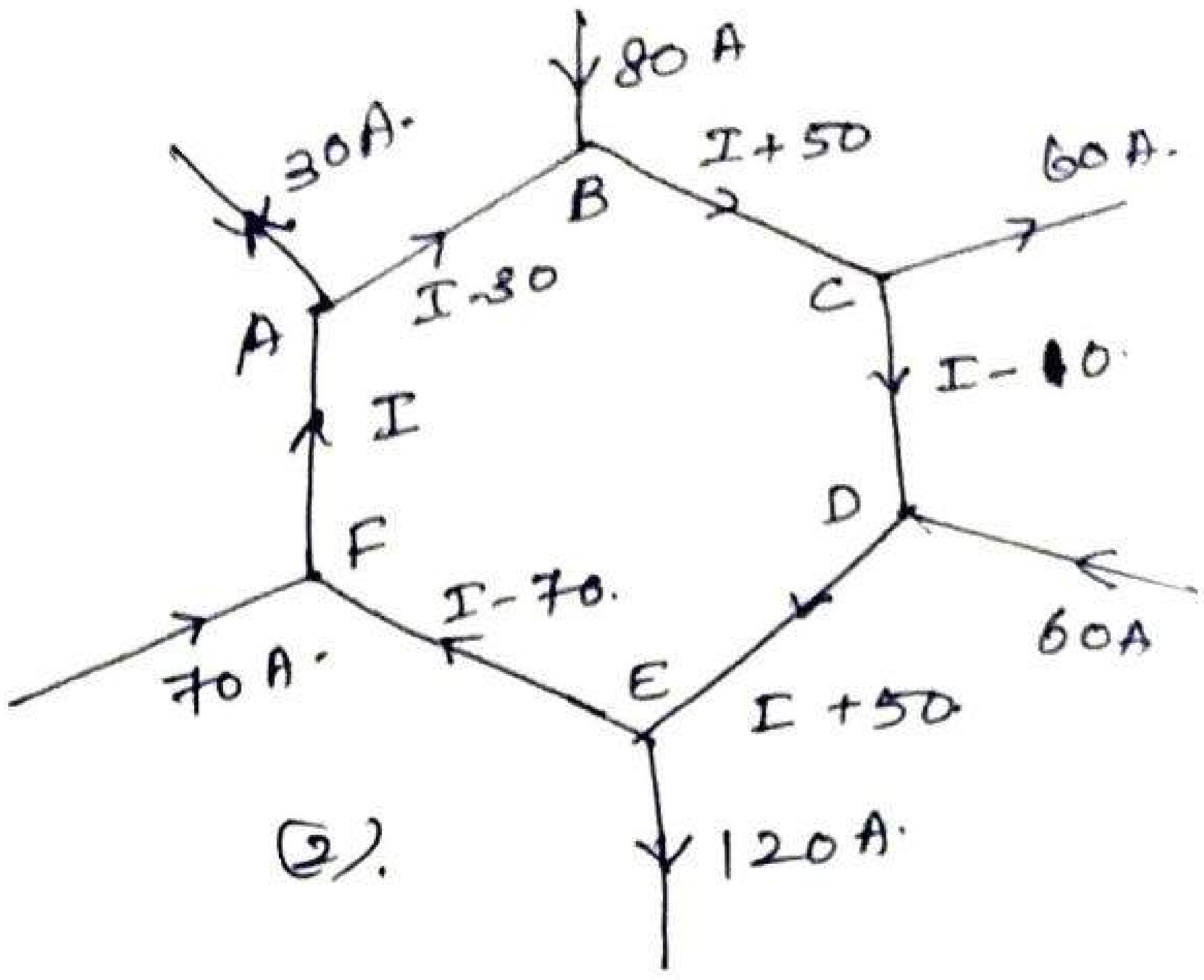
$= 25 \times 0.333 =$

$V_{AB} = 8.325V$

Find the curret. through all the branches in the n/w.



(1)



(2).

Soln- mark the currents as shown in fig (2)

In loop ABCDEFA.

Let current the' branch ~~B~~FA be ~~as~~ I.

Applying KVL for loop,

$-0.02(I-30) - 0.02(I+50) + 0.02(I-10) - 0.03$ [illegible] $(I+50) + (0.01)(I-70) - 0.01I = 0.$

$0.02I - 0.6 + 0.02I + 1 + 0.01I - 0.1 + 0.03I$

$+1.5 + 0.01I - 0.7 + 0.01I = 0.$

$0.1I + 1.1 = 0.$

$I = \frac{+1.1}{0.1} = +11A$

I is in the opposite direction

$I_{FA} = I = -11A$

$I_{AB} = I - 30 = -41A$

$I_{BC} = I + 50 = 39A$

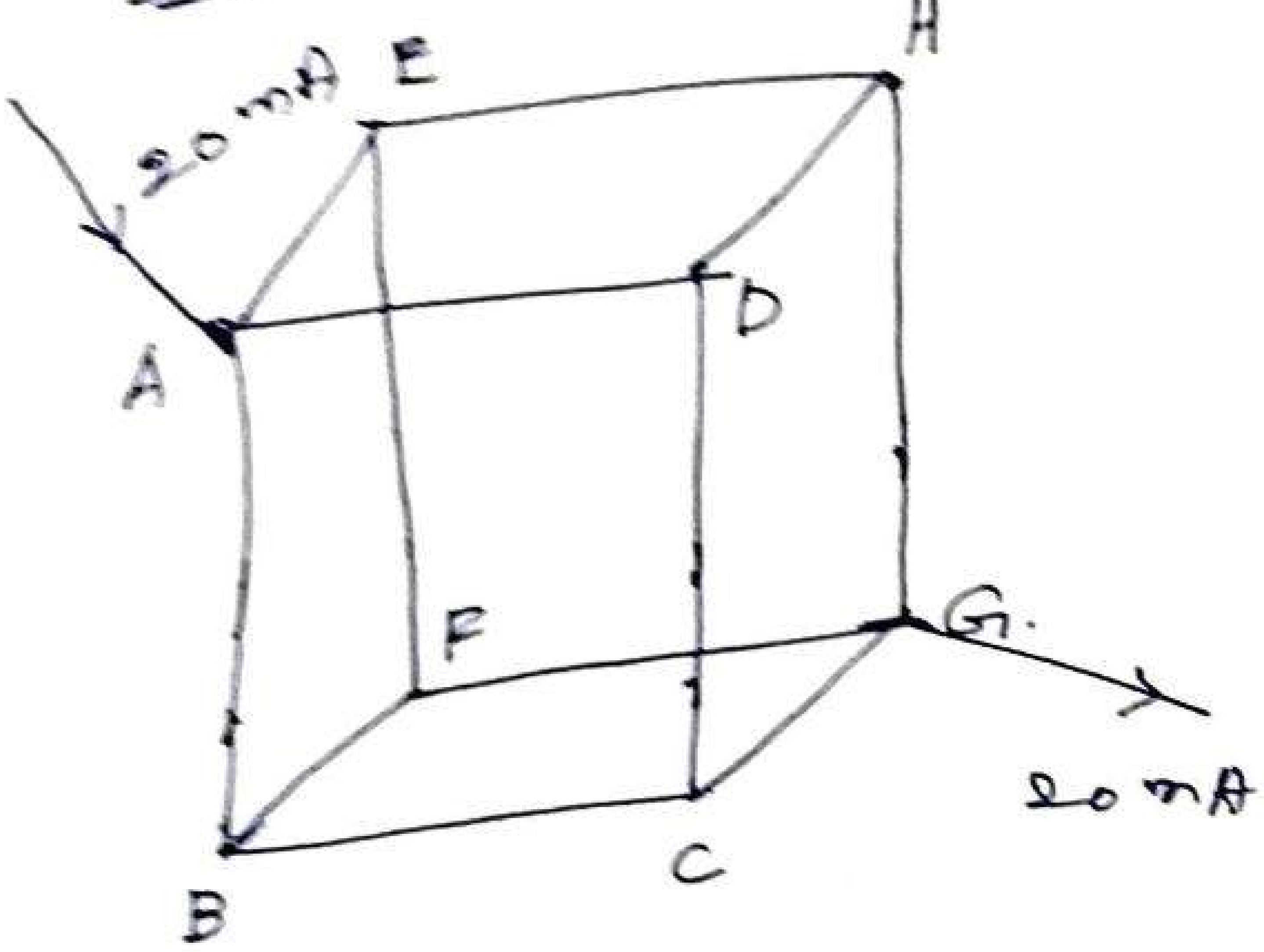
$I_{CD} = I - 10 = -21A$

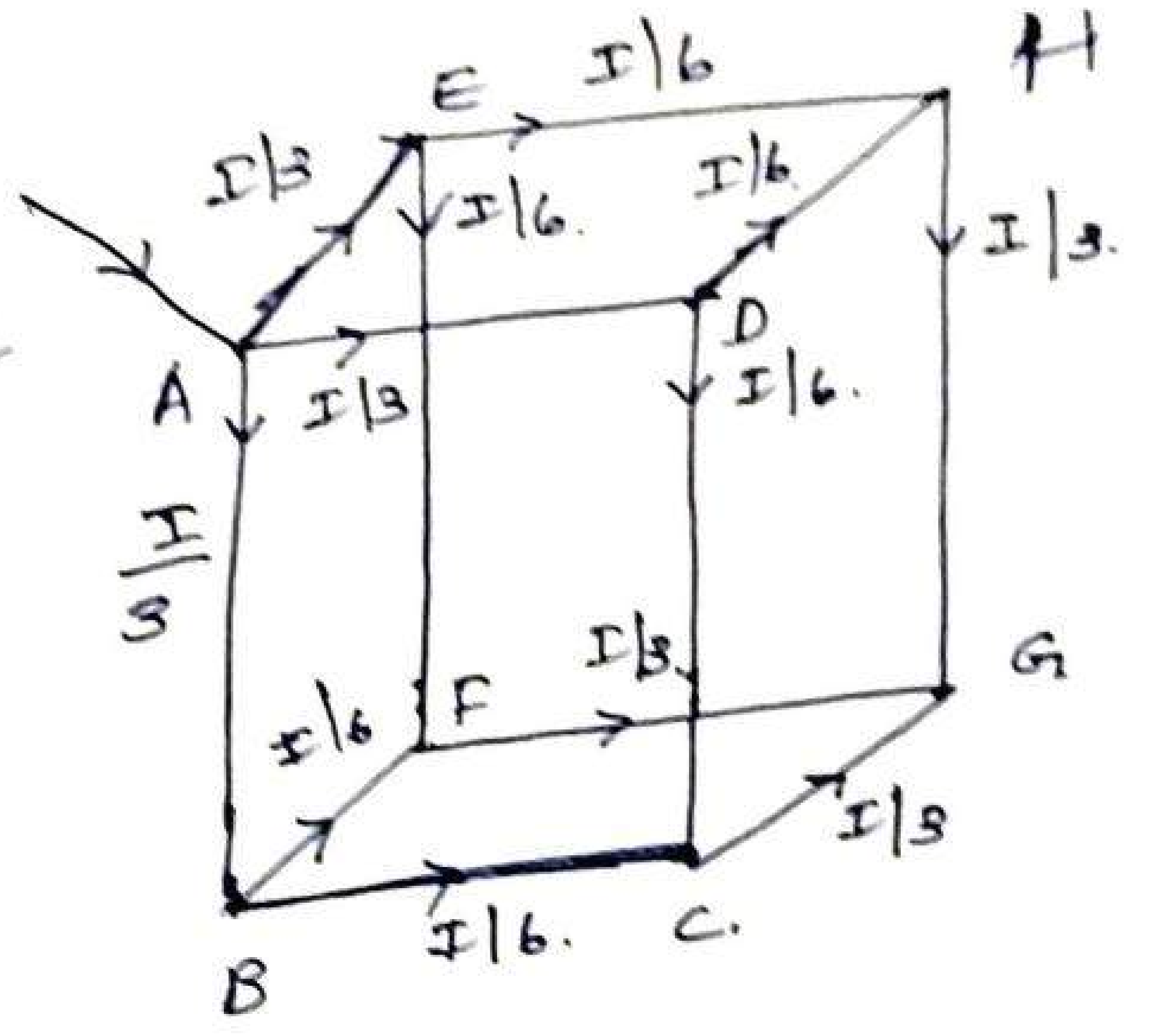
$I_{DE} = I + 50 =$ 39A.

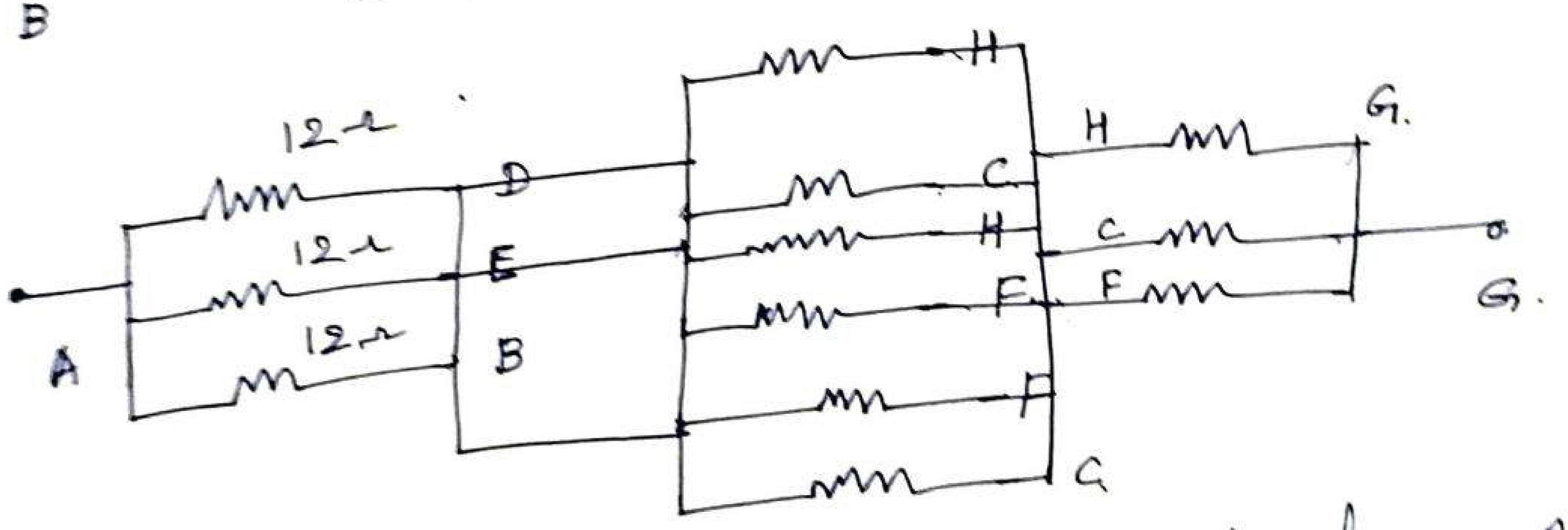
$I_{EF} = I - 70 = -81A$

Twelve identical wires, each of resist 12Ω, are arranged to form the edges of a cube as shown in fig. A currt. of 20mA enters into the cube at the corner A and leaves it at the diagonally opposite corners. Calculate the p.d between these two corners.

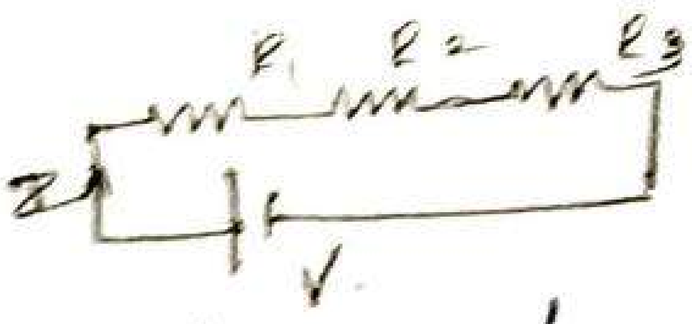
Soln. $R_{AG} = 4 + 2 + 4 = 10\Omega$. $V_{AG} = 20mA \times 10$ $= 0.2V$







Due to symmetry of the n/w, the currt. of 20mA will divide equally into the branches AD, AE, AB.
∴ The potentials of points D, E & B will be same.
|||ly, equal currents will be flowing in the branches HG, CG, FG. and the point H, C, F will be at the same potential. If the pts at the same potential are joined together, the currt distribution in the branches will not change.



Characteristics of Series ckts.

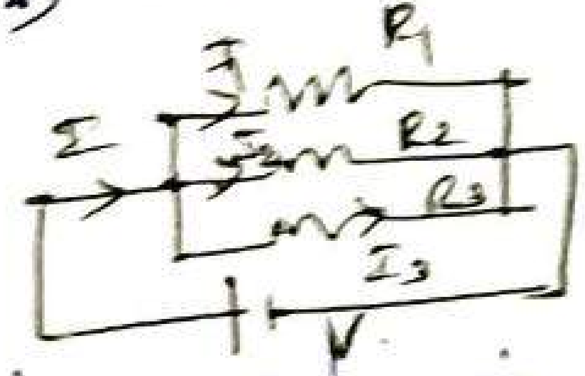
① The same currt. flows through each resistance.

2) The supply voltage V is the sum of the individual voltage drops across the resistances. $V = V_1 + V_2 \dots + V_n$

③. The equivalent resistance is equal to the sum of the individual resistances.

④. The eqt. resistance is ~~the~~ larger than any individual resistance.

⑤ Power is additive. The total power consumed is the sum of the powers consumed in individual resists.



Characteristics of parallel ckts.

① The potential difference across each resistor is same.

②. The total current is the sum of all the individual currts.

$$I = I_1 + I_2 + I_3 + \dots I_n.$$

③ The reciprocal of the equivalent resist is equal to the sum of the reciprocal of individual resistances.

④. The equivalent resistance is smaller than all the resistances in - parallel.

⑤ The total power consumed in the ckt. is sum of the powers consumed in individual resistances.

Characteristics of Series ckts

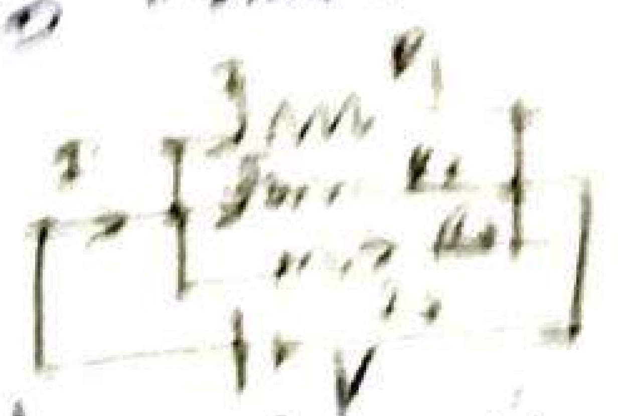
① The same current flows through each resistance

2) The supply voltage V is the sum of the individual voltage drops across the resistances. $V = V_1 + V_2 + \cdots$

③ The equivalent resistance is equal to the sum of the individual resistances.

④ The eqt. resistance is larger than any individual resistance.

⑤ Power is additive. The total power consumed is the sum of the powers consumed in individual resistances.



Characteristics of parallel ckts.

① The potential difference across each resistor is same

② The total current is the sum of all the individual currents

$$I = I_1 + I_2 + I_3 + \cdots I_n$$

③ The reciprocal of the equivalent resist is equal to the sum of the reciprocal of individual resistances.

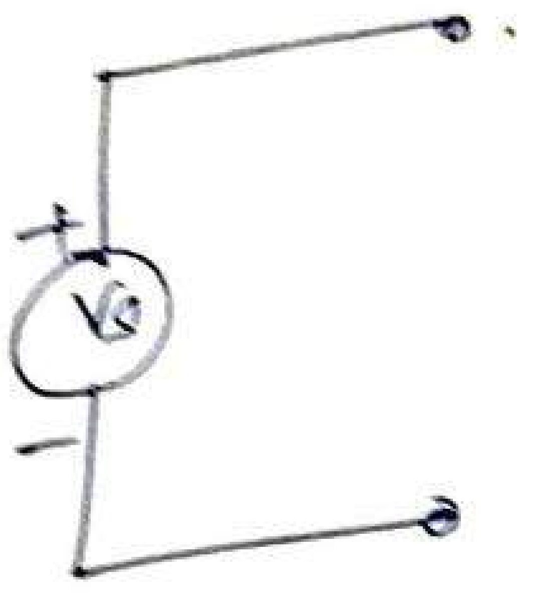
④ The equivalent resistance is smaller than all the resistances in parallel.

⑤ The total power consumed in the ckt is sum of the powers consumed in individual resistances

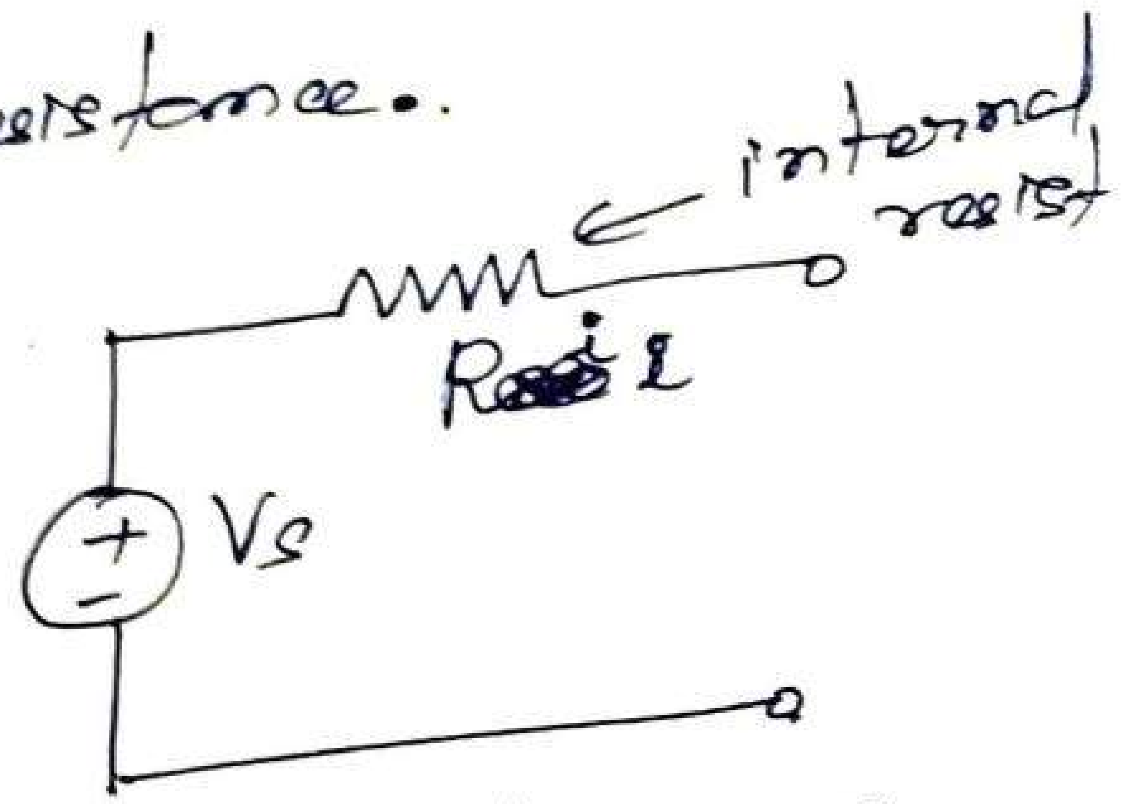
Voltage Source

Ideal voltage source is the energy source which gives constant output voltage irrespective of the current drawn from it.

Practical voltage source is an ideal voltage source in series with an internal resistance.



Ideal voltage source

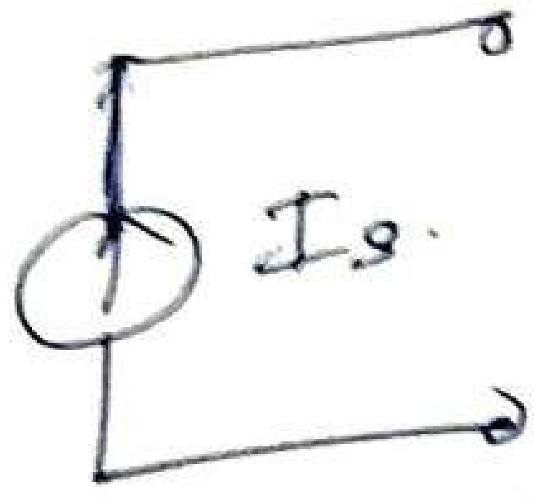


Practical source

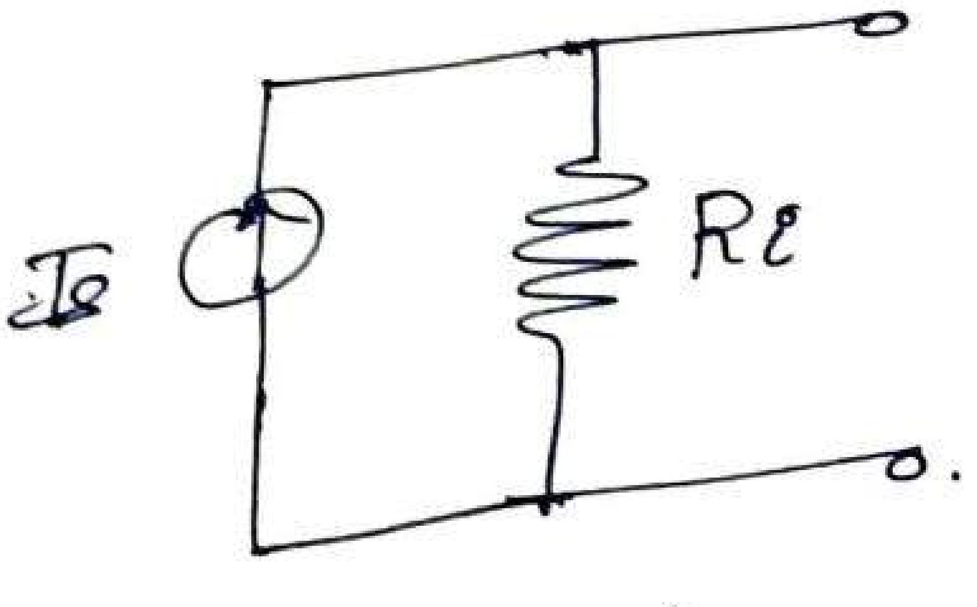
Current source –

Ideal current source is defined as a source which delivers a constant current, independent of its output voltage.

Practical current source is modelled as an ideal current source in parallel with a resistance, known as its internal resistance.



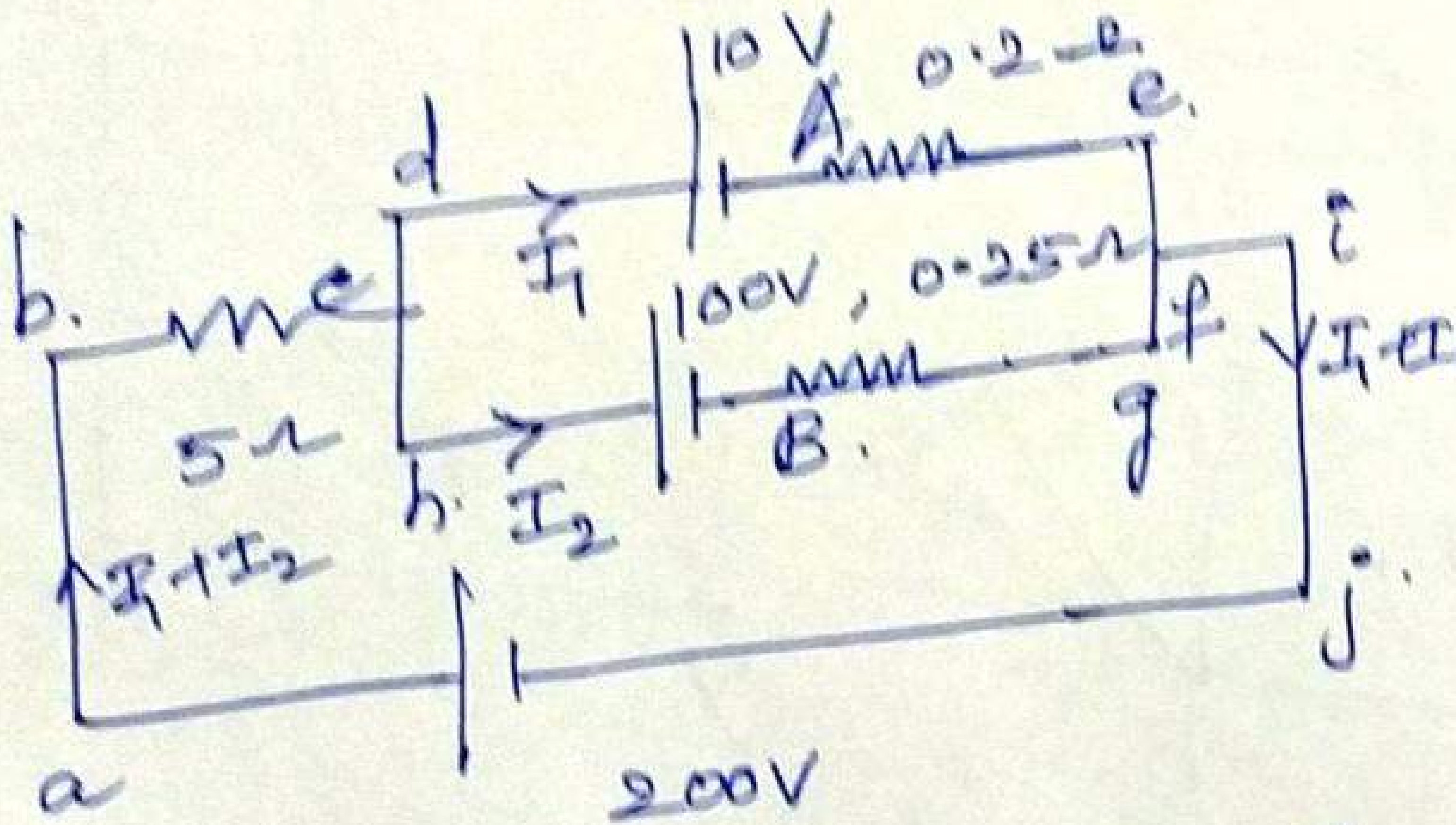
Ideal currt source



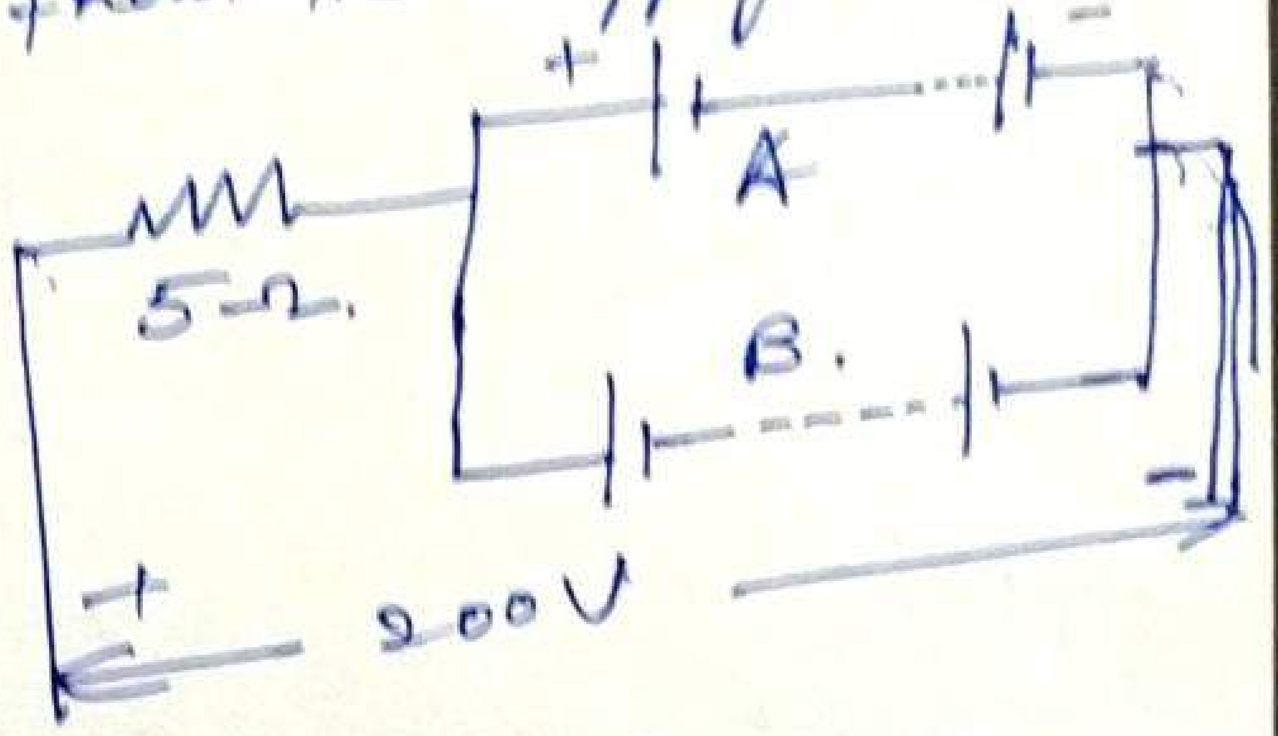
Practical currt source

Dec 2010.

(8m) Two batteries are connected as shown in fig. to a 200V supply. Battery A has an emf of 110V and internal resist. of 0.2 Ω. Battery B has an emf of 100V and internal resist of 0.25 Ω. Detmn. the magnitude and direction of the current in each battery and the total current taken from the supply. (8m)



⇐



Soln Let I_1 & I_2 be the currents flowing through batteries A & B resply as shown.

For the loop cdefghc, Apply KVL.

$-110 - 0.2 I_1 + 0.25 I_2 + 100V = 0$.

$-0.2 I_1 + 0.25 I_2 = 110 - 100 = 10$. — ①.

For the closed loop. abcdefja

$-5(I_1+I_2) - 110 - 0.2 I_1 + 200 = 0$.

$-5.2 I_1 - 5 I_2 = -200 + 110 = -90$.

$5.2 I_1 + 5 I_2 = +90$ — ②.

$$\begin{bmatrix} -0.2 & 0.25 \\ 5.2 & 5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 90 \end{bmatrix}.$$

$$I_1 = \begin{vmatrix} 10 & 0.25 \\ 90 & 5 \end{vmatrix} \Big/ \begin{vmatrix} -0.2 & 0.25 \\ 5.2 & 5 \end{vmatrix} = \frac{\Delta_1}{\Delta}$$

$I_1 = -11.97A$

$$I_2 = \frac{\Delta_2}{\Delta} = \begin{vmatrix} -0.2 & 10 \\ 5.2 & 90 \end{vmatrix} \Big/ \Delta.$$ $I_2 = 80.43A$

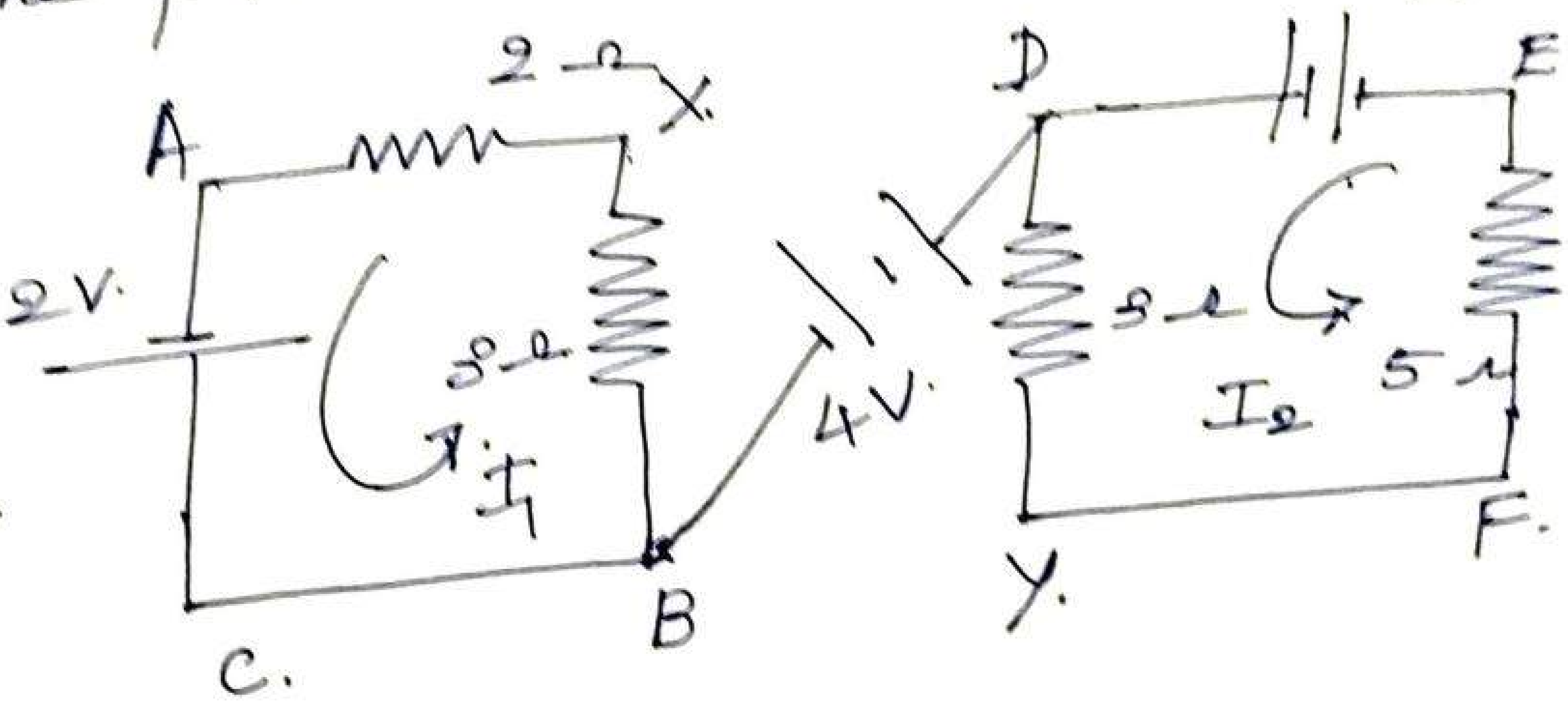
$I_1 = \frac{27.5}{-2.3} = \underline{\underline{-11.96A}}$ ⇒ Current thr' battery A from e to d.

$I_2 = \frac{-70}{-2.3} = \underline{\underline{30.43A}}$ → current thr' battery B from h to g.

Total current from the supply, $I_1 + I_2 = -11.96 + 30.43$
$= \underline{\underline{18.47 A}}$

---

(29) Jul'09 Obtain the potential difference Vxy in the ckt.



Apply KVL to AXBCA,

$2I_1 + 3I_1 - 2 = 0.$

$5I_1 = 2.$

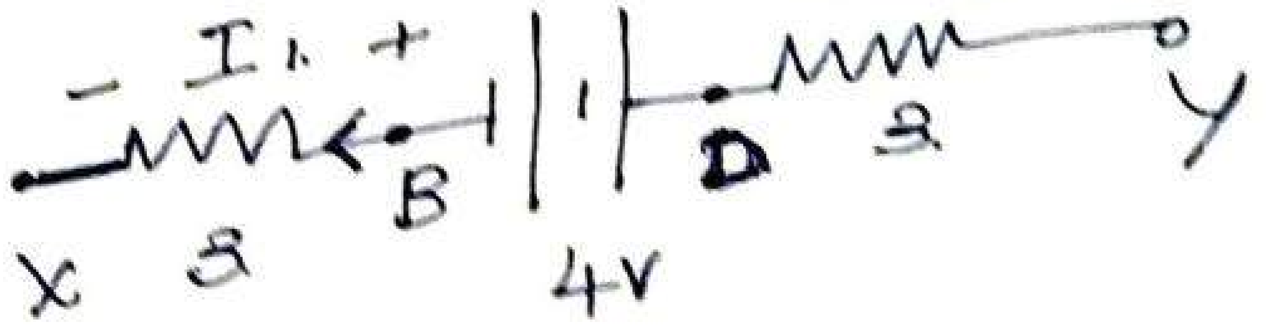
$I_1 = \frac{2}{5} = \underline{\underline{0.4A}}$

Apply KVL to loop DEFYD.

$-4 + 3I_2 + 5I_2 = 0.$

$8I_2 = 4$

$I_2 = \frac{4}{8} = \frac{1}{2} = \underline{\underline{0.5A}}$



$V_{xy} =$

$V_{xy} = -3I_1 + 4 + 3I_2$

$-3(0.4) \mp 4 + 3(0.5) = \underline{\underline{-3.7V}}$

$V_{xy} = -3.7V.$

X is at lower potential.

Y is at higher potential.

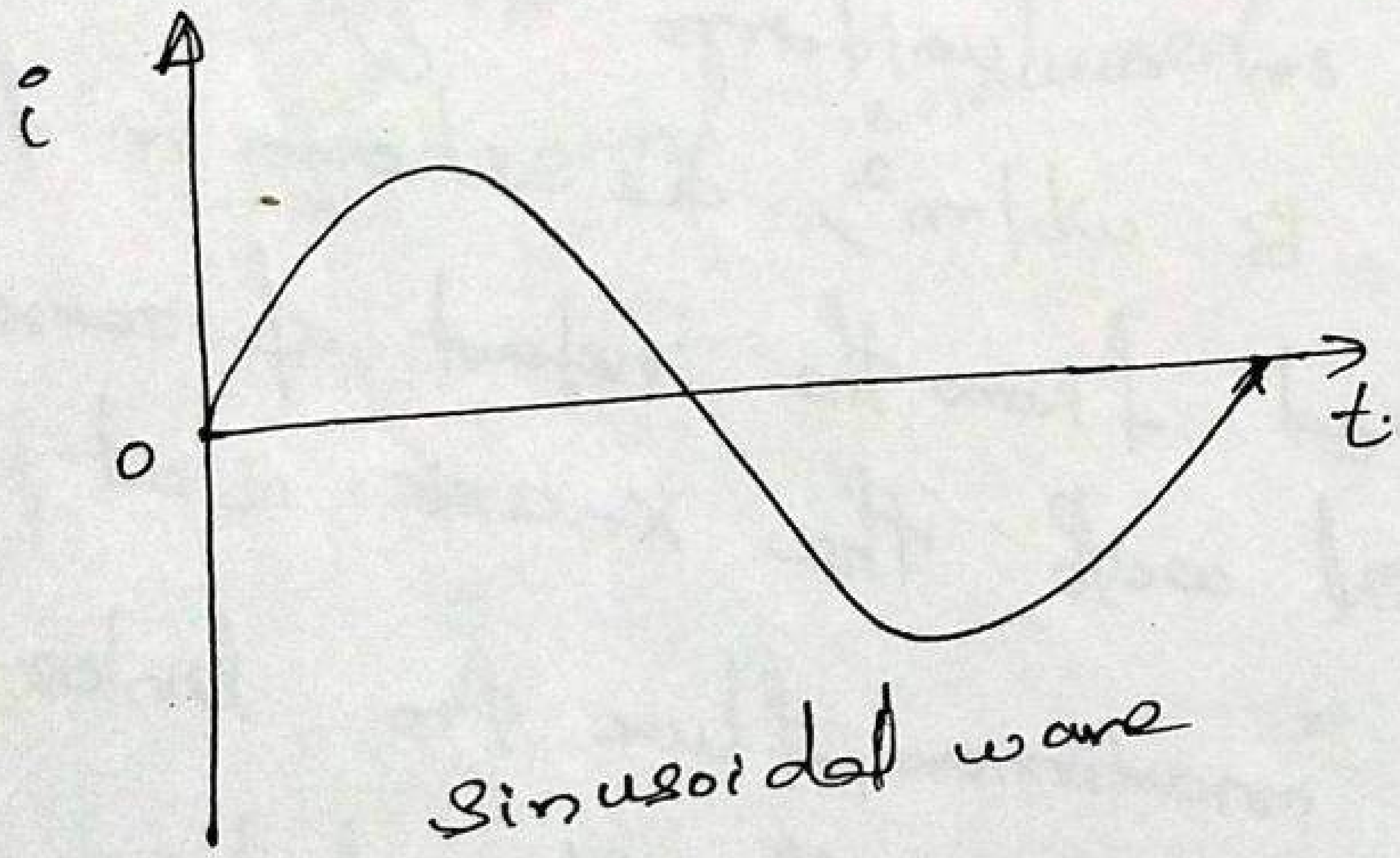
By— Vishalini Divakar, AP, ECE Dept, KSIT.

Single phase A C ckts

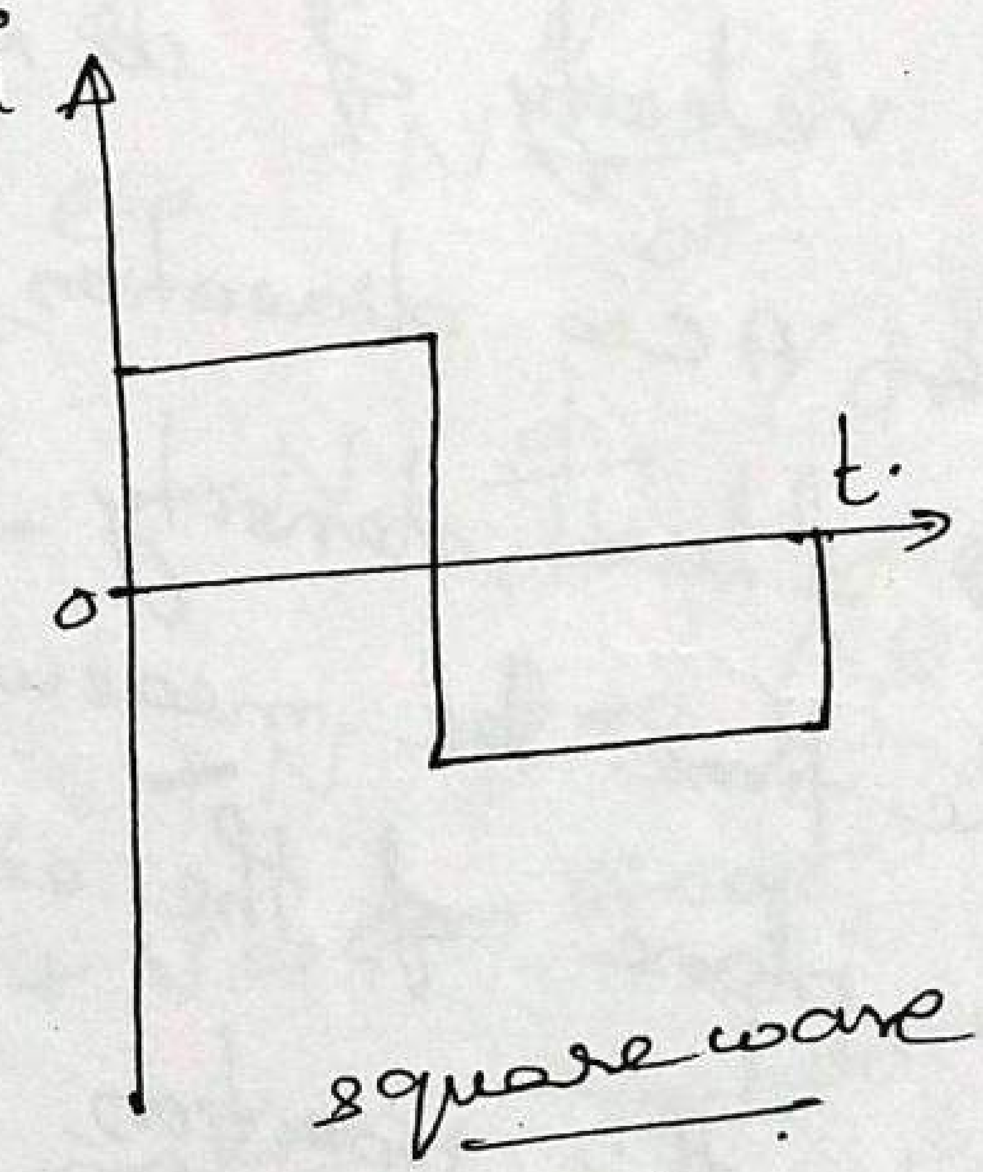
An a.c ckt. is a ckt. which has an alternating voltage sources due to which alternating currents flow through the various elements of the ckt. like resistance, inductance and capacitance.

An alternating quantity (V or I) is a quantity whose magnitude changes continuously with time but can have only two directions, either +ve or -ve.

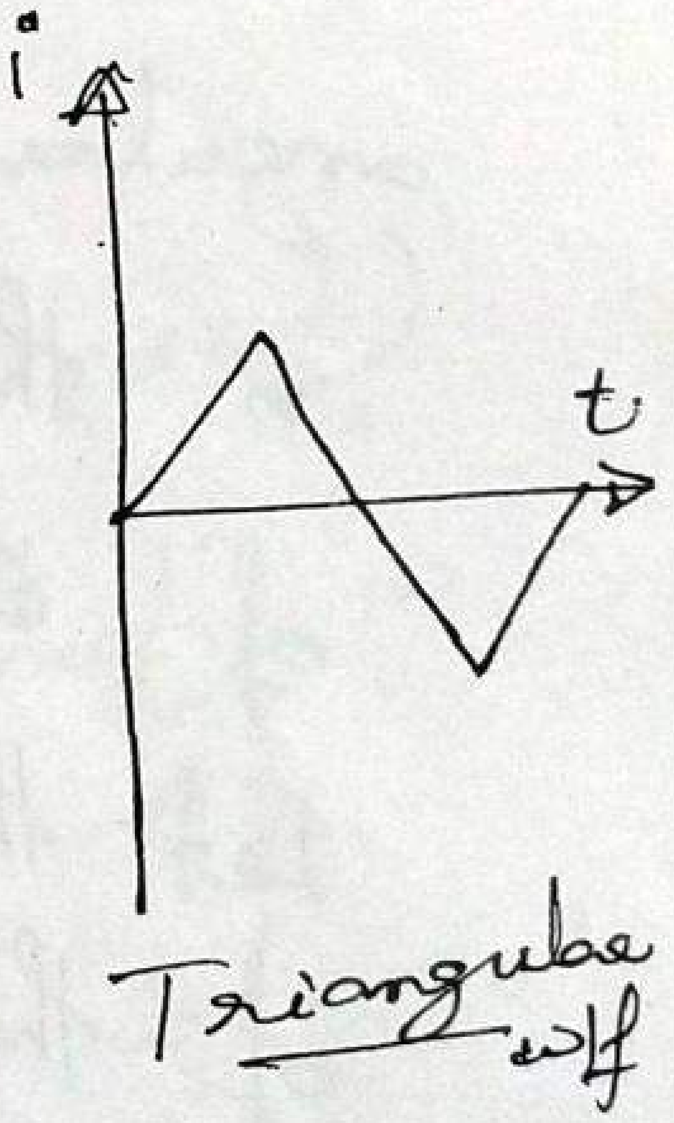
They are periodic in nature and can be represented by periodic waveforms as shown below.



Sinusoidal wave



square wave

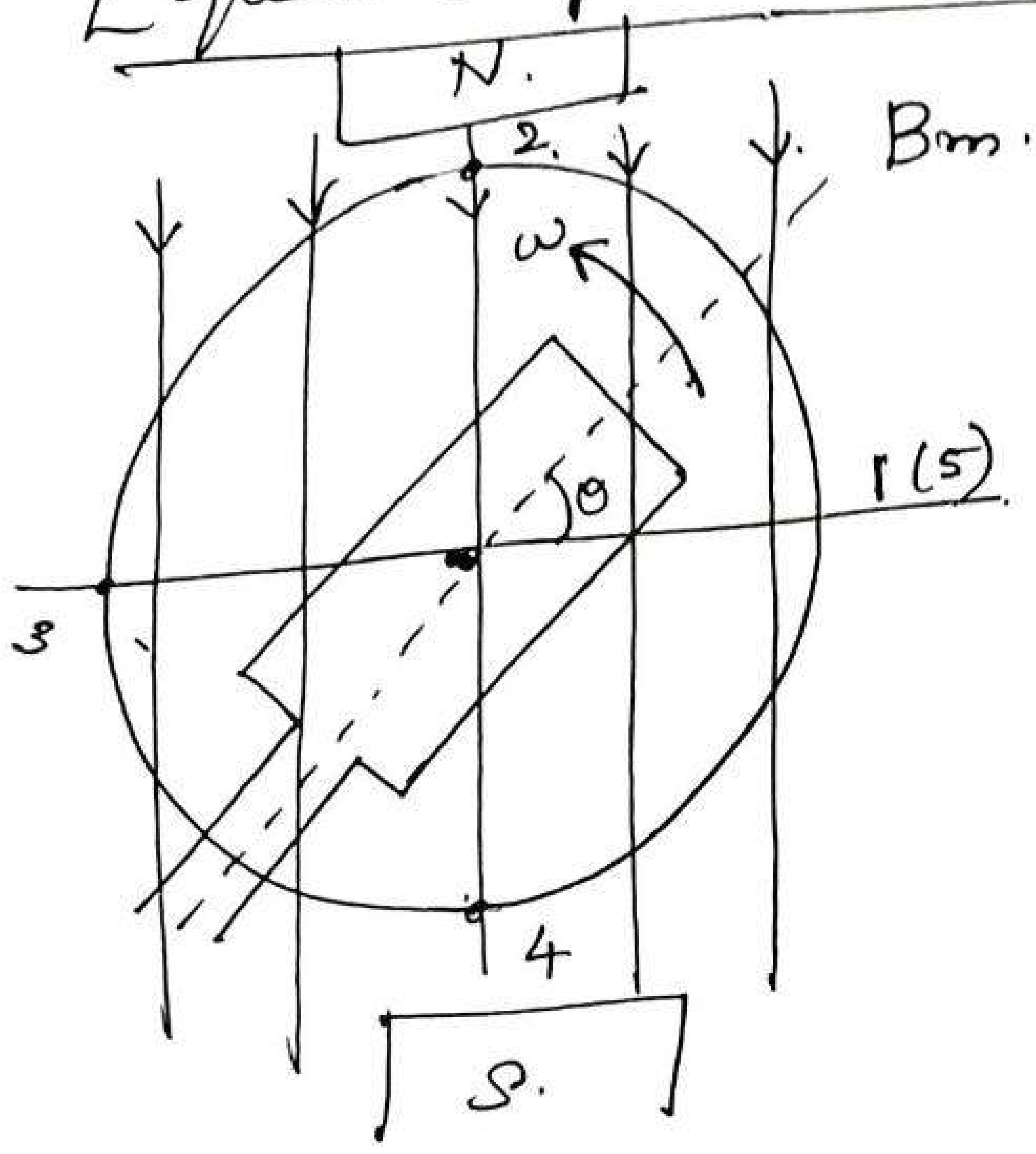


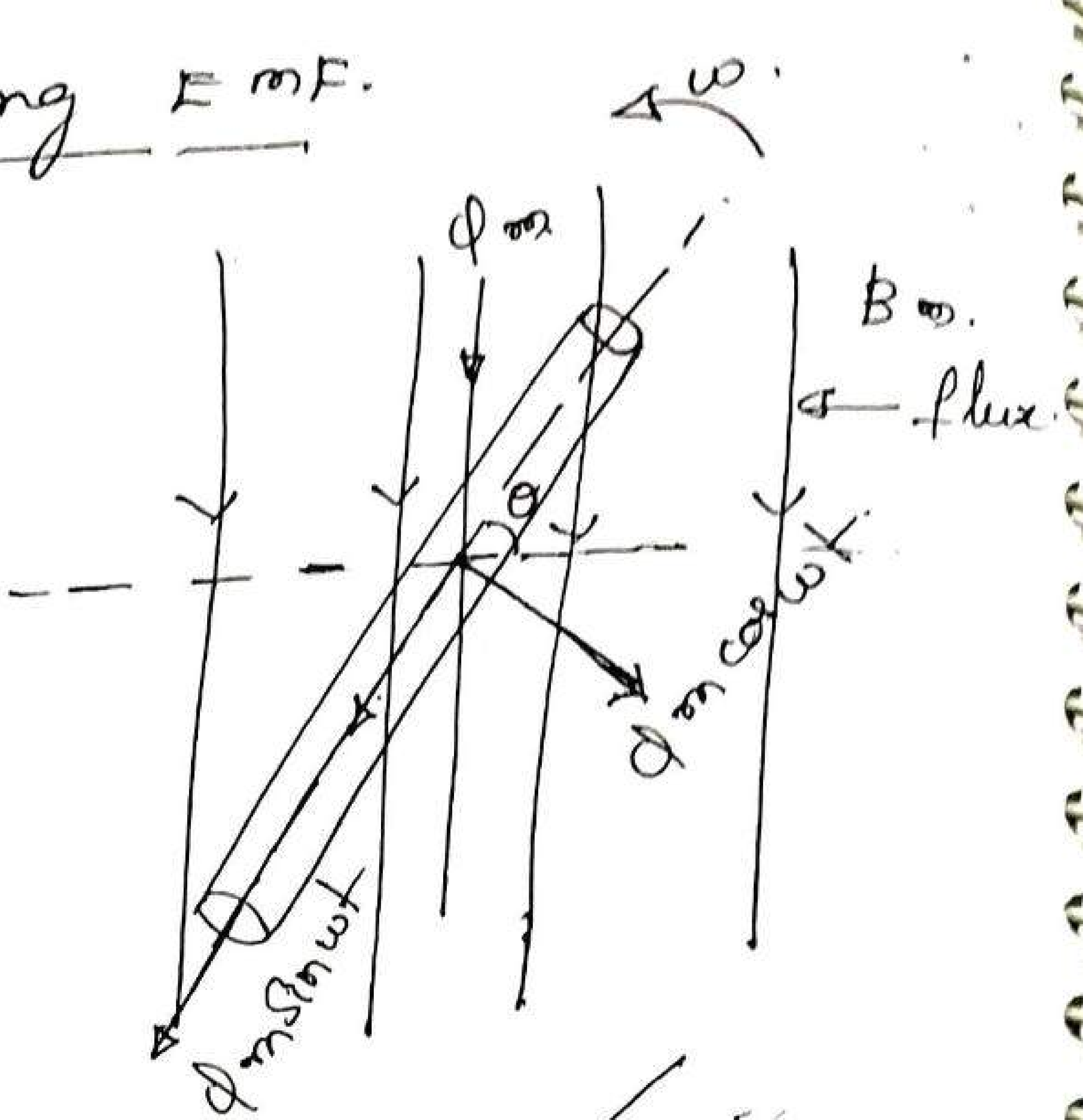
Triangular w/f

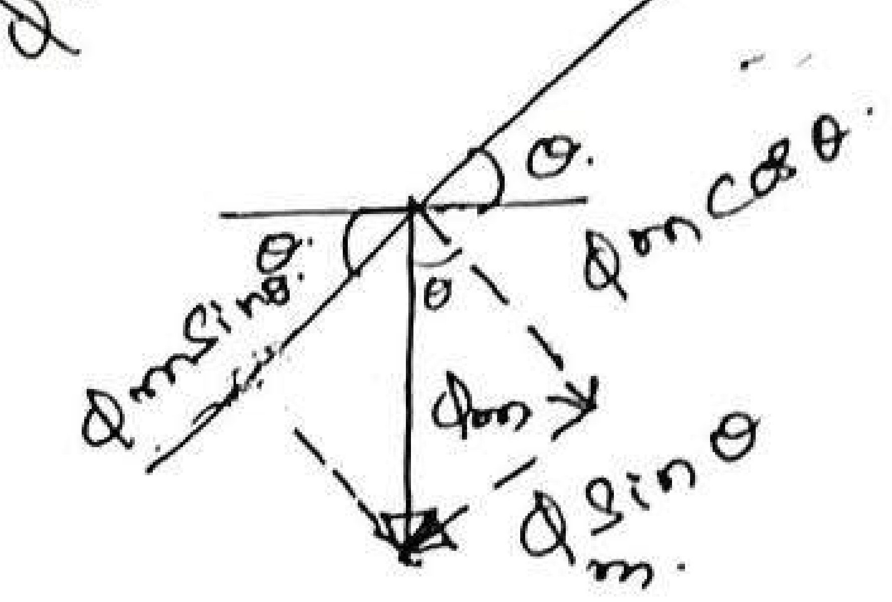
Generation of Sinusoidal A C voltage.

Alternating voltage can be generated either by rotating a coil in a magnetic field or by rotating the magnetic field within a stationary coil.

Equation of alternating EMF.







Consider a rectangular coil of N turns rotating with an angular velocity of ω rads/sec. in the ACW direction, in a uniform magnetic field of ~~B~~ flux density B wb/m², as shown in fig. Let the time be measured from the instant of coincidence of the plane of the coil with the x-axis. i.e at position 1. At this position, maximum flux φm links with the coil. As the coil rotates, the flux linking with it changes and also the emf induced in the coil. At position 1, the flux cut is minimum and emf induced is zero. At position 2, the flux cut is maximum and the emf induced also is max.

when the coil turns through an angle θ in time 't' seconds, $\theta = \omega t$, as shown in fig., the flux ϕ_m can be resolved into two components:

(a) $\phi_m \sin\omega t$ parallel to the plane of the coil. This component does not induced emf as it is parallel to the plane of the coil.

(b) component $\phi_m \cos\omega t$, ⊥r to the plane of the coil which induced emf in the coil.

∴ Flux linkages of coil at θ° is,

$$N\phi = N\phi_m \cos\omega t$$

Accdg. to Faraday's laws of em.agnetic induction, the emf induced $e = -N \frac{d\phi}{dt}$.

$$= -N \frac{d}{dt} (\phi_m \cos\omega t)$$

$$= +N \phi_m (-\sin\omega t)\,\omega$$

$$e = +N\omega\phi_m \sin\omega t \quad -(1)$$

The value of 'e' is maxm. when $\omega t = 90^\circ$

Then, $e = E_m = N\omega\phi_m$ (1)

Substing this value in (1),

$$\underline{\underline{e = E_m \sin\omega t}} = 2\pi f N \phi_m \sin\omega t$$

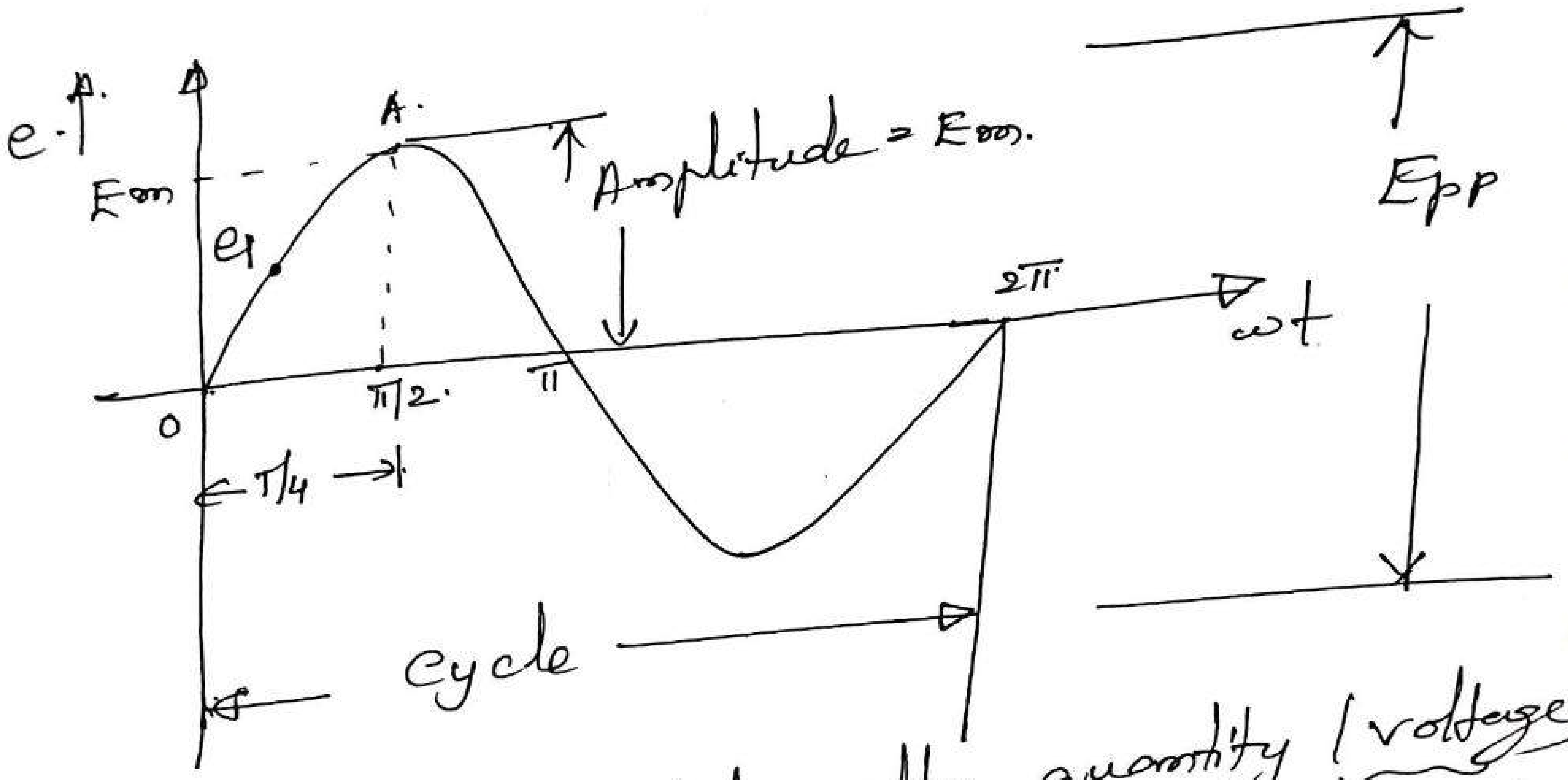
$$\overline{\overline{e = E_m \sin\theta}} = N\, 2\pi f B_m A \sin\omega t$$

Hence the emf induced in the coil is sinusoidal in nature

$$e = 2\pi f N B_m A \sin\omega t$$

Definitions

1. **waveform** - The graph between an alternating quantity (voltage or currt.) and time is called wavefor The altg. quantity is taken along the y-axis and time along the x-axis. as shown in fig.



A w/f showing sinusoidal altg. quantity (voltage).

2. **Instantaneous value.** - The value of an alternating quantity at any instant is called instantaneous value and is represented by v, i, e etc

3. **Amplitude** - The maximum value, positive or negati which an alternating quantity attains during one complete cycle is called amplitude or peak value or maximum value. It is represented by

Em, Vm or Im respectively for voltage & current

4. Time period and frequency - The time taken in secs by an altg. quantity to complete one cycle is known as periodic time and is denoted by T.

The no. of cycles completed per sec by an altg. quantity is known as frequency and is denoted by f. and is expressed in Hertz (Hz)

f — 1 sec

1 — T.

The no. of cycles / sec = f. or $f = \frac{1}{T}$.

periodic time $T = \frac{1}{f}$.

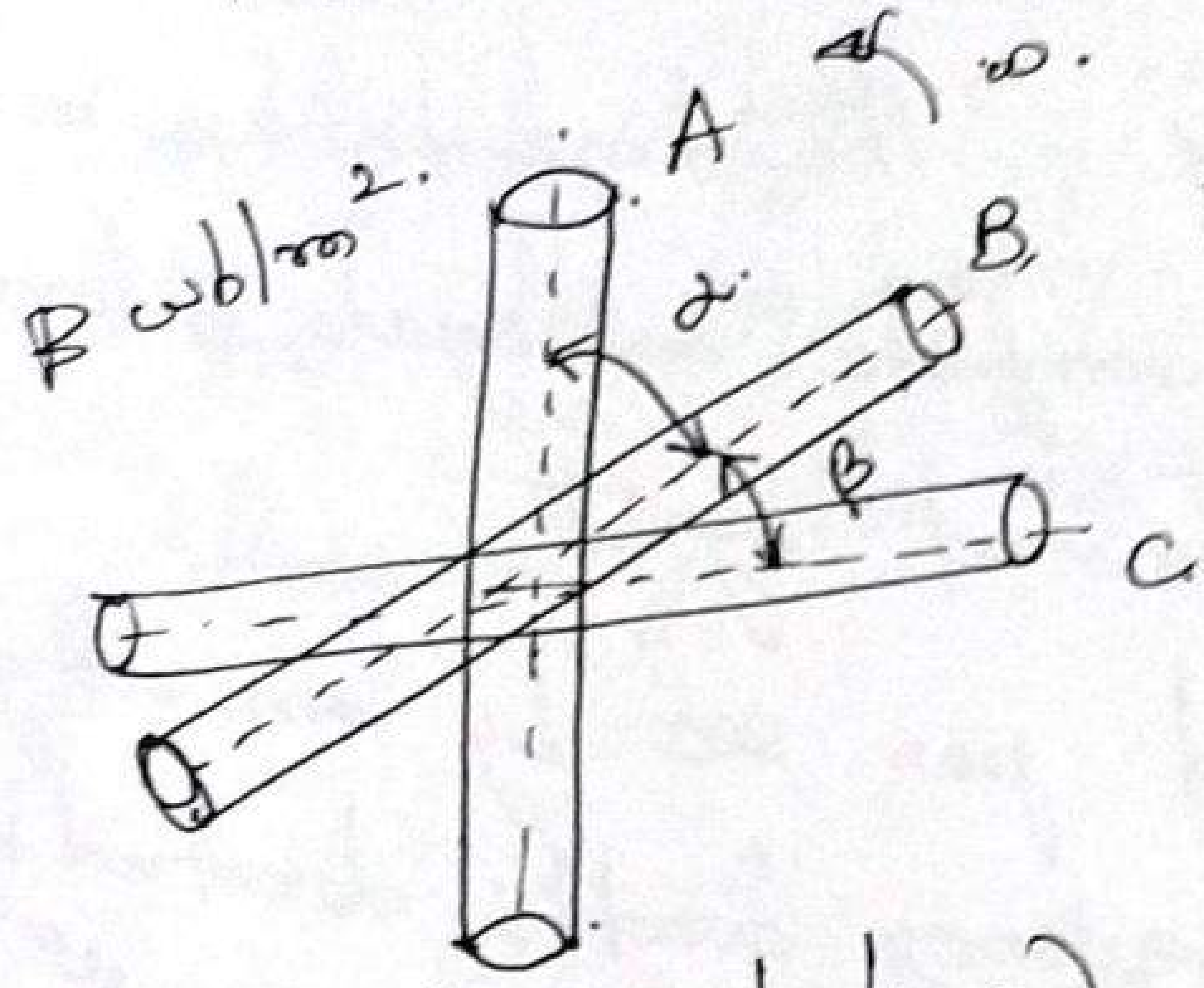
5. Peak to peak value - The maximum variation between the maximum +ve instantaneous value and the maximum -ve instantaneous value is the peak to peak value and is represented by Epp, Vpp or Ipp for voltage and current resply.

For a sinusoidal w/f, Epp = 2Em.

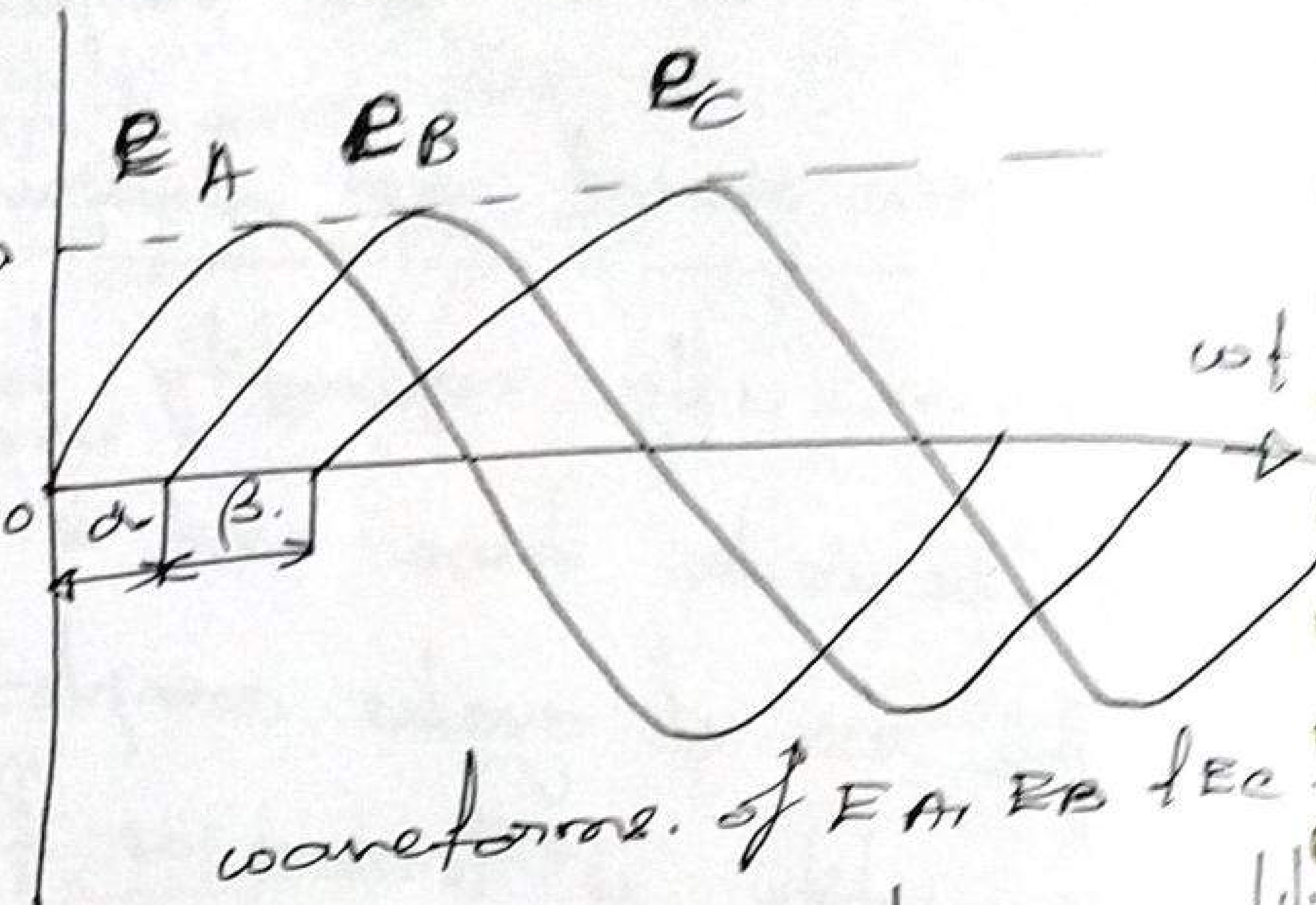
6. Phase - of an altg. quantity is the fraction of the time period that has elapsed since it last passed through the zero position of reference.

The phase of voltage at pt A is T/4 sec or $\frac{\pi}{2}$ rads

phase difference



3 coils (rotating)



waveforms of EA, EB & EC.

Phase difference between two alternating quantiti is the angle difference between the two rotating vectors representing the two quantities.

Consider 3 coils (identical) which are displaced from each other by angles α and β and rotating in a uniform magnetic field with the same angular velocity 'ω' rad/sec as shown in fig. In this case, the values of the induced emfs are the same but they are displaced by angles α and β as shown.

i.e. $e_A = E_m \sin\omega t$ $e_B = E_m \sin(\omega t - \alpha)$

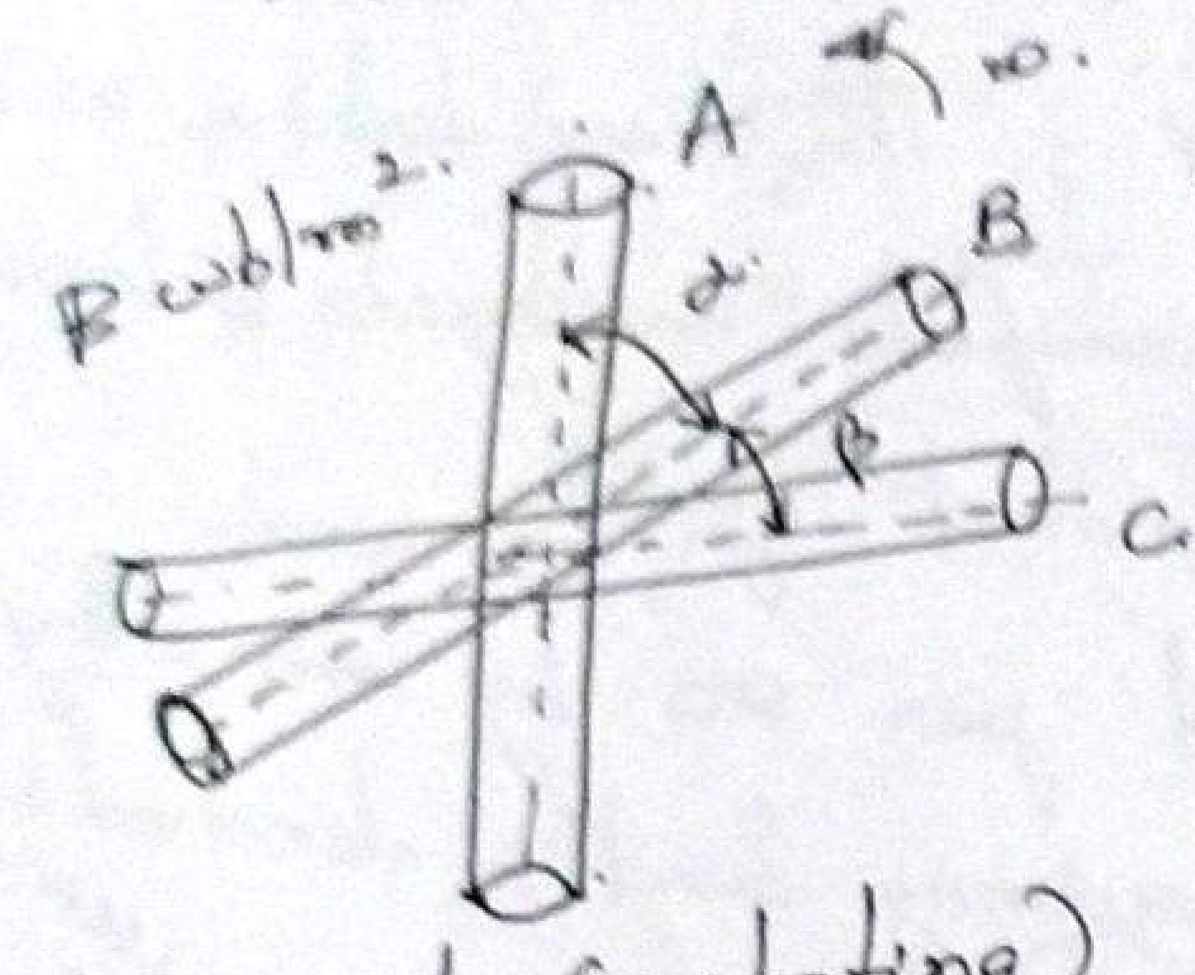
& $e_C = E_m \sin(\omega t - (\alpha+\beta))$

The three emfs reach their zero or maxm. valu one after the other as shown.

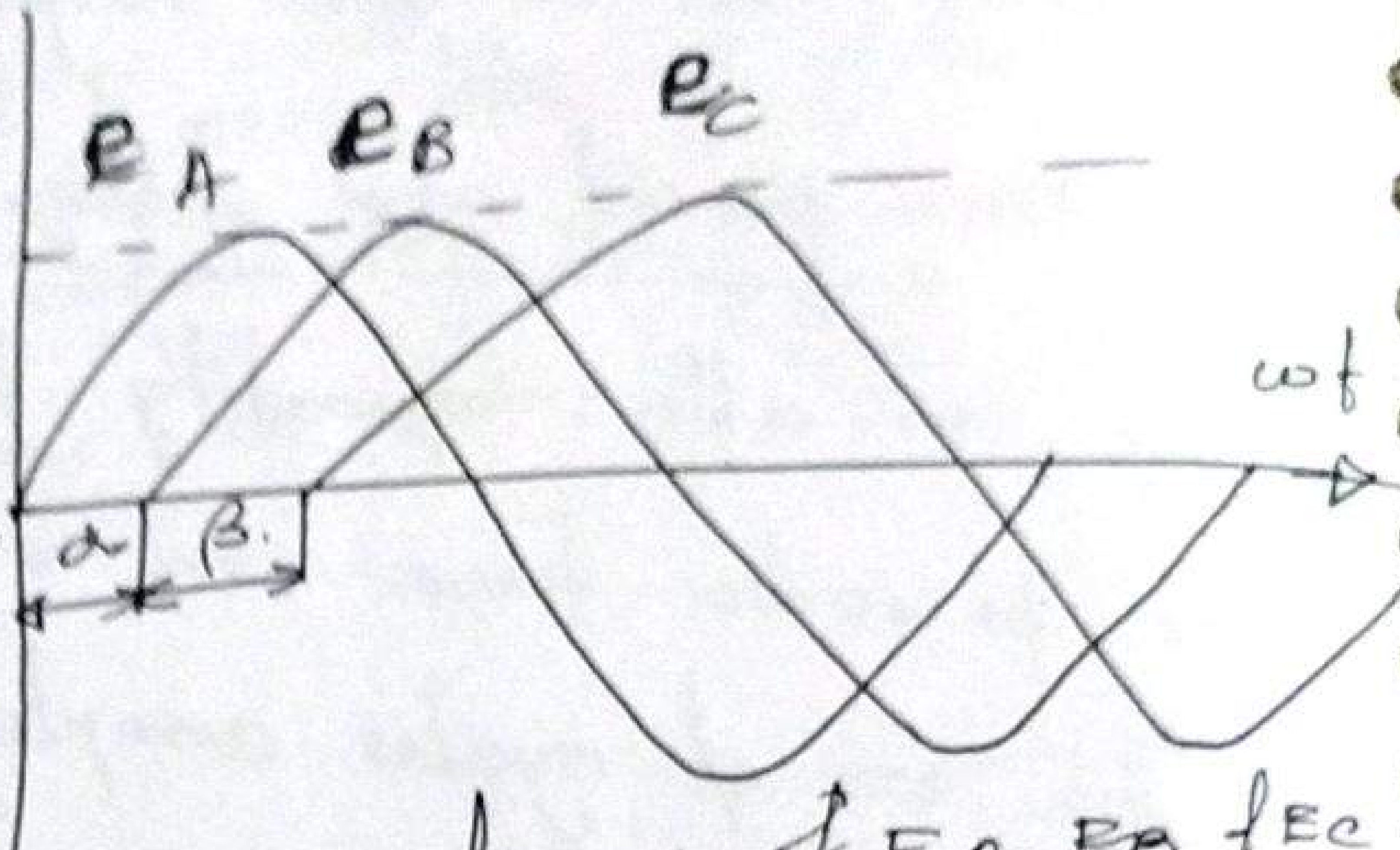
The phase difference b/n e_A & e_B is $\angle\alpha$.

The phase difference between e_B & e_C is $\angle\beta$.

phase difference



3 coils (rotating)



waveforms of EA, EB & EC.

Phase difference between two alternating quantiti is the angle difference between the two rotating vectors representing the two quantities.

Consider 3 coils (identical) which are displaced from each other by angles α and β and rotating in a uniform magnetic field with the same angular velocity 'ω' rad/sec as shown in fig. In this case, the values of the induced emfs are the same but they are displaced by angles α and β as shown.

ie $e_A = E_m \sin\omega t$ $e_B = E_m \sin(\omega t - \alpha)$

& $e_C = E_m \sin(\omega t - (\alpha+\beta))$

The three emfs reach their zero or maxm. valu one after the other as shown.

The phase difference b/w e_A & e_B is $\angle\alpha$.

The phase difference between e_B & e_C is $\angle\beta$.

Hence, e_A is said to be leading e_B by $\angle\alpha$ and e_A leads e_C by $\angle\alpha+\beta$.

(1) The two quantities are said to be inphase with each other. if they pass through their zero and maxm. values simultaneously.

(2) A leading quantity is one which reaches its maximum or zero value earlier than the other.

(3) A lagging quantity is one which reaches its zero or maxm. value later than the other.

Hence e_B lags e_A by an angle of α.

e_A leads e_B by $\angle\alpha$.

e_B leads e_C by $\angle\beta$.

e_A leads e_C by $\angle\alpha+\beta$.

Root mean square value. (R.m.s)

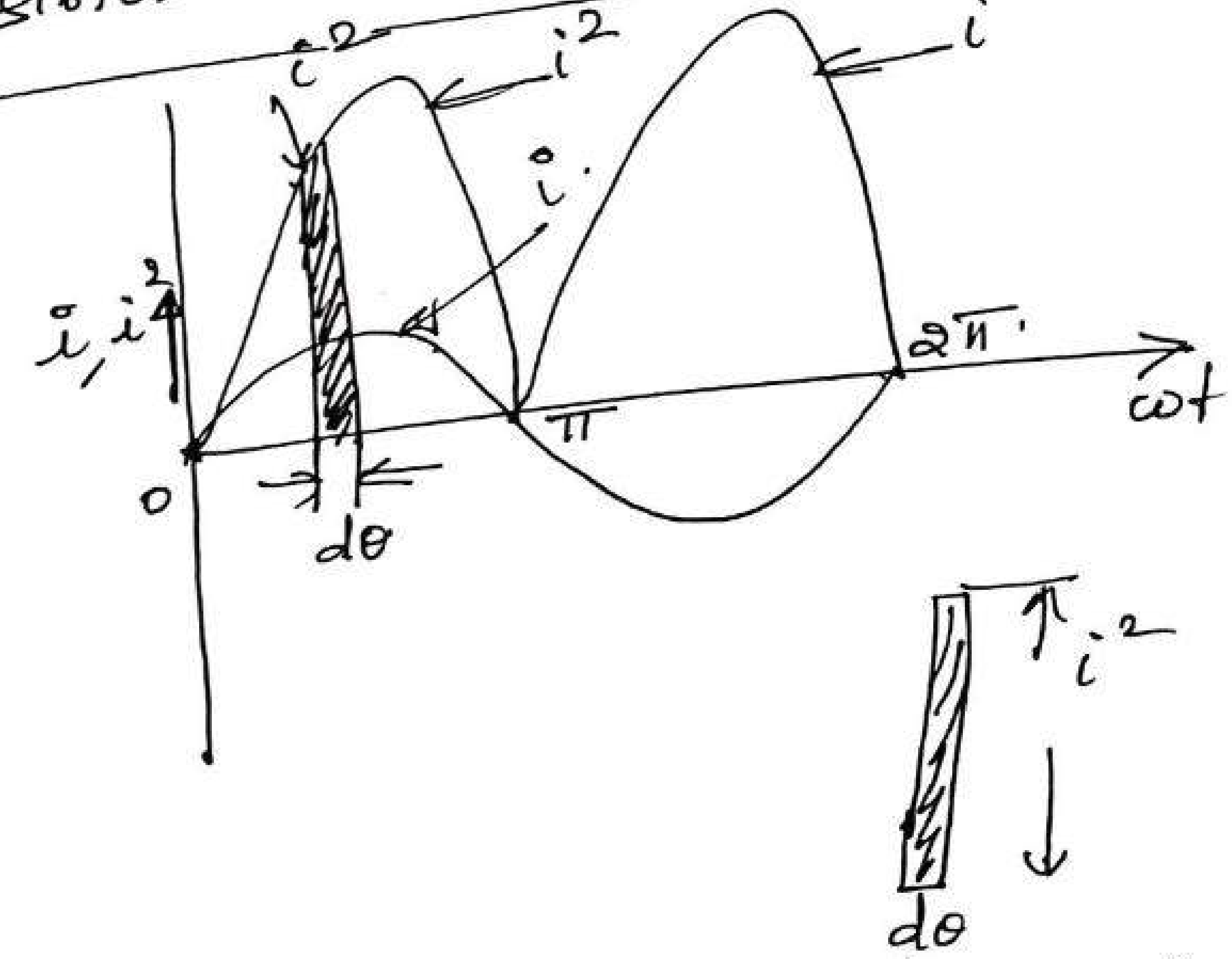
Defn.—The R.m.s or effective value of an alternating current is defined as that steady current (d.c) which when flowing through a given resistance for a given time produces the same amount of heat as produced by the alternatg. curnt. when flowing through the same resist. for the sametime.

Average value (I_{av})

The average value of an altg. current is equal to that steady current (dc) which transfers the same amount of charge as transferred by the alternating current. across the same ckt. during the same time.

It is also equal to the arithmetical average of all the values of an alternatg quantity over one cycle.

Rms value of a sinusoidal quantity.



The equation of an alternating current varying sinusoidally is given by

$$i = I_m \sin\theta.$$

The waveform for i and i^2 (squared wave) are shown in fig. Consider an elemental strip of thickness $d\theta$ in the first half cycle of the squared wave as shown. Let i^2 be the midordinate of the strip.

Area of the elemental stripe = $i^2 d\theta$.

Area of the first half cycle of squared wave

$$= \int_0^\pi i^2 \, d\theta$$

$$= \int_0^\pi (I_m \sin\theta)^2 \, d\theta$$

$$= I_m^2 \int_0^\pi \sin^2\theta \, d\theta$$

$$= I_m^2 \int_0^\pi \left(\frac{1-\cos 2\theta}{2}\right) d\theta$$

$$= \frac{I_m^2}{2} \left[\theta - \frac{\sin 2\theta}{2}\right]_0^\pi$$

$$= \frac{I_m^2}{2} \left[\pi - 0\right] - \left[\overset{0}{\cancel{\sin 2\pi - \sin 0}}\right]$$

Area of squared wave $= \frac{\pi I_m^2}{2}$.

But $I_{rms} = \sqrt{\frac{\text{Area of first half cycle of squared wave}}{\text{base}}}$

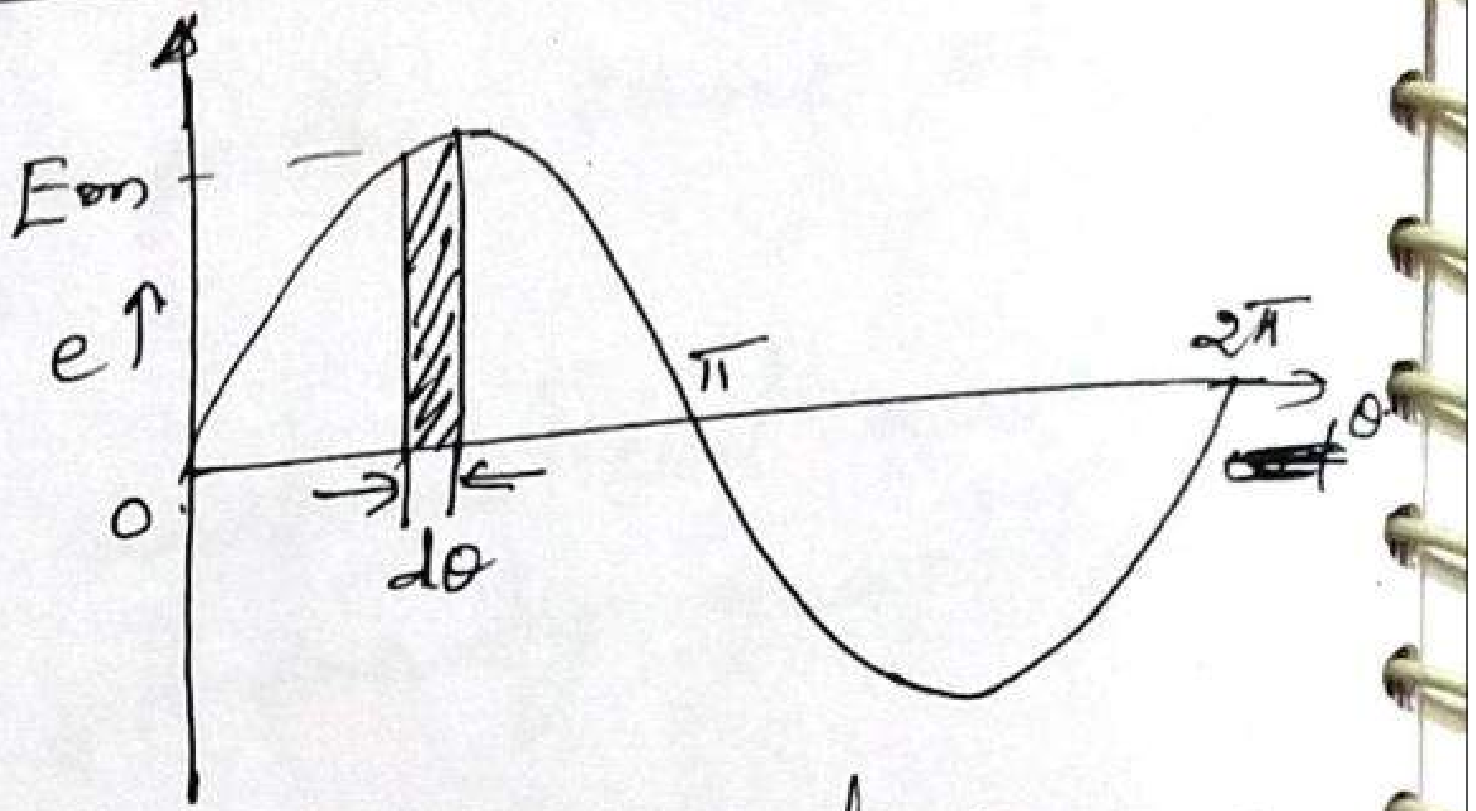
$$= \sqrt{\frac{\pi I_m^2}{2} \times \frac{1}{\pi}}$$

$$= \sqrt{\frac{I_m^2}{2}}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} = \underline{\underline{0.707 \, I_m}}$$

|||ly, $E_{rms} = \frac{E_m}{\sqrt{2}} = 0.707\, E_m$.

Average value of an alternating (sinusoidal) quantity



In case of a symmetrical wave, like sinusoidal quantity, the positive half is exactly equal to the negative half and the average value for the entire cycle is zero. Hence, the average value is obtained by adding the instantaneous values of voltage over half cycle only.

The equation of a sinusoidal voltage is,

$$e = E_m \sin\theta$$

Let us consider an elementary strip of thickness $d\theta$ in the first half cycle as shown. Let the midordinate of this strip is 'e'.

Area of the strip $= e\, d\theta$.

Area of first half cycle $= \int_0^{\pi} e\, d\theta$

$$= \int_0^{\pi} E_m \sin\theta\, d\theta.$$

$$= E_m \Big[-\cos\theta\Big]_0^{\pi} = -E_m(-1-1)$$

$$= 2E_m$$

ii Average value = $\frac{\text{Area of half cycle}}{\text{base}}$

$$E_{av} = \frac{2E_m}{\pi}$$

$$E_{av} = 0.637\ E_m.$$

IIIly, $I_{av} = 0.637\ I_m.$

Form factor. – is the ratio of effective (Rms) value to ~~peak~~ average value of an alternating quantity.

Form factor $k_f = \frac{\text{Rms value}}{\text{Average value}}$

$$= \frac{0.707\ I_m}{0.637\ I_m}$$

$$K_f. = 1.11$$

Peak factor or crest factor or Amplitude factor.

It is the ratio of maximum value to the Rms value of an altg. quantity.

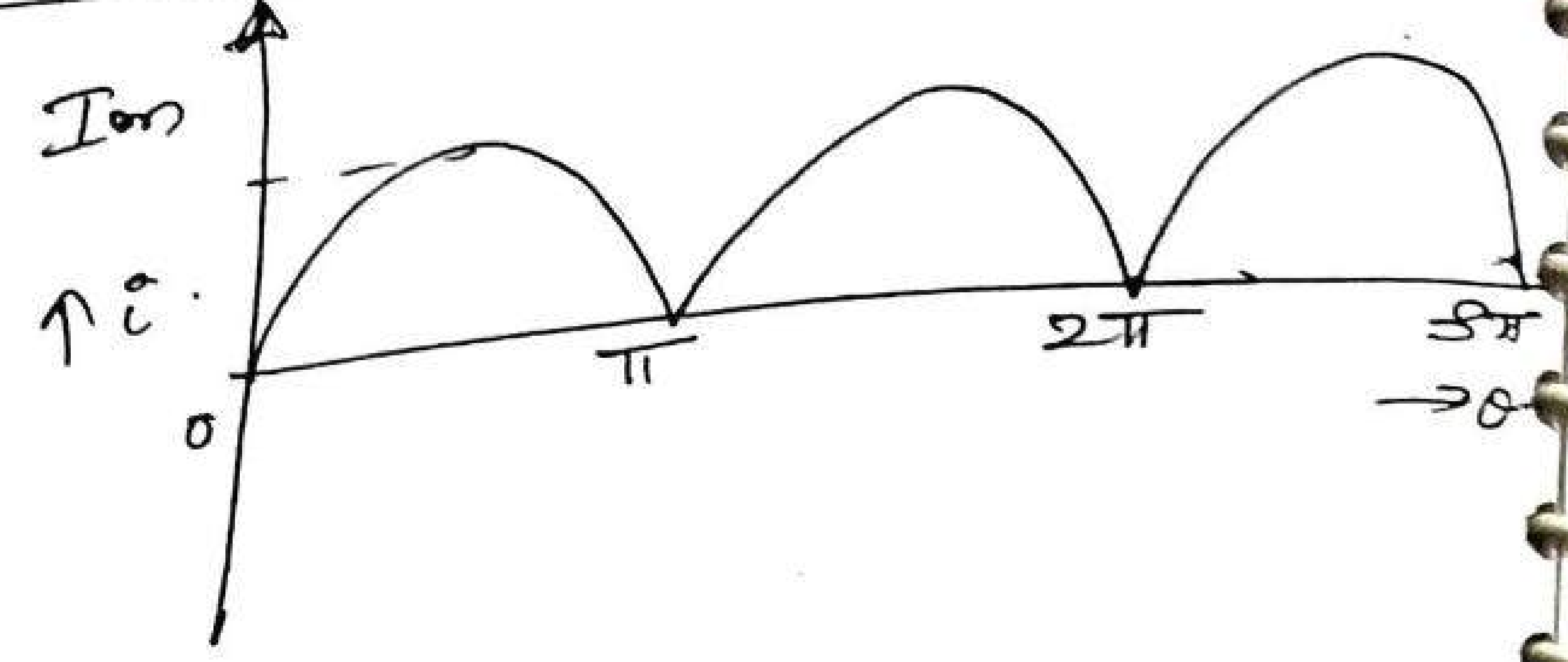
$$K_p = \frac{\text{Maxm value}}{\text{Rms value}} = \frac{I_m}{I_m/\sqrt{2}} =$$

$$K_p. = 1.414$$

$$\text{or.} = \frac{E_m}{E_m/\sqrt{2}} = 1.414.$$

Rms value of a full wave rectifier w/f.

$i = I_m \sin\theta.$



$$I_{rms} = \sqrt{\int_0^{\pi} \frac{i^2 \, d\theta}{\pi}}.$$

$$= \sqrt{\frac{1}{\pi} \int (I_m^2 \sin^2\theta) \, d\theta}.$$

$$= \sqrt{\frac{I_m^2}{2\pi} \int_0^{\pi} (1 - \cos 2\theta) \, d\theta}.$$

$$= \frac{I_m^2}{2\pi} \left(\theta - \frac{\sin 2\theta}{2} \right]_0^{\pi}.$$

$$I_{rms} = \sqrt{\frac{I_m^2}{2\pi} (\pi - 0)} - (\cancel{\sin 2\pi - \sin 0}) \to 0.$$

$$I_{rms} = \sqrt{\frac{I_m^2}{2}} = \frac{I_m}{\sqrt{2}}.$$

Average value

$$I_{av} = \int_0^{\pi} \frac{i \, d\theta}{\pi}.$$

$$= \int_0^{\pi} \frac{I_m \sin\theta}{\pi} d\theta = \frac{I_m}{\pi} \int_0^{\pi} \sin\theta \, d\theta.$$

$$= -\frac{I_m}{\pi} \left[\cos\theta \right]_0^{\pi} = \frac{-I_m}{\pi} \left[\cos\pi - \cos 0 \right]$$

$$I_{av} = \frac{2 I_m}{\pi} \quad \therefore k_f = \frac{I_m/\sqrt{2}}{2I_m/\pi} = 1.11.$$

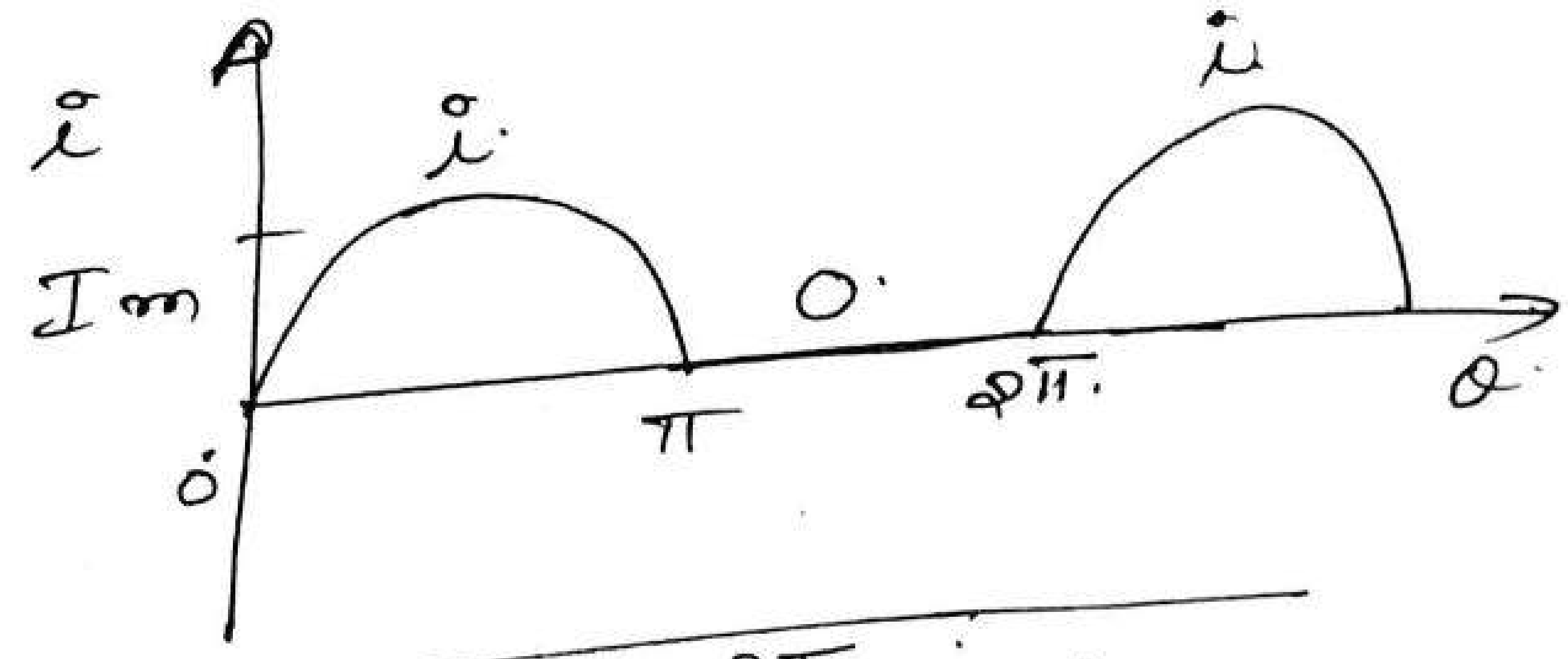
$$k_f = \frac{I_m}{I_{rms}}$$

$$k_f = \frac{I_m}{I_m/\sqrt{2}}$$

$$\sqrt{2} = 1.414$$

Rms value for half wave rectifier o/p

$$I_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} i^2 \, d\theta}$$



$$= \sqrt{\frac{1}{2\pi}\int_0^{\pi} I_m^2 \sin^2\theta \, d\theta + \frac{1}{2\pi}\int_{\pi}^{2\pi} 0 \, d\theta}$$

$$= \sqrt{\frac{I_m^2}{4\pi}\int_0^{\pi}\left(\frac{1-\cos 2\theta}{\cancel{2}}\right) d\theta + 0}$$

$$= \sqrt{\frac{I_m^2}{4\pi}\left[\theta - \frac{\sin 2\theta}{2}\right]_0^{\pi}}$$

$$= \sqrt{\frac{I_m^2}{4\pi}\left[(\pi - 0) - \cancelto{0}{\left(\frac{\sin 2\pi - \sin 0}{2}\right)}\right]}$$

$$= \sqrt{\frac{I_m^2 (\pi)}{4\pi}} =$$

$$\boxed{I_{rms} = \sqrt{\frac{I_m^2}{4}} = \frac{I_m}{2}}$$

Average value

$$I_{av} = \frac{1}{2\pi}\int_0^{\pi} i \, d\theta$$

$$= \frac{1}{2\pi}\int_0^{\pi} I_m \sin\theta \, d\theta$$

$$= \frac{I_m}{2\pi}\left[-\cos\theta\right]_0^{\pi} = \frac{-I_m}{2\pi}\left[\cos\pi - \cos 0\right]$$

$$\boxed{I_{av} = \frac{I_m}{\pi}}$$

$$K_f = \frac{I_m/2}{I_m/\pi} = 1.57$$

$$K_o = 2. = \frac{I_m}{I_m/2}$$

Assignment Questions - Theory (2)

Jul09, 4m)

①. Define ① form factor ③ peak factor and ② power factor in ac ckts. (6m)

② Obtain the form factor of full rectified sine wave. (5m)

Dec'11

③. Draw the phasor diagm. for RL series ckt. and derive the expression for real power. (6m)

Jan07.

④. For a R-L-C series ckt ⓐ. discuss the nature of p.f for ① $X_L > X_C$ ② $X_L < X_C$ ③ $X_L = X_C$ (6m)
ⓑ. Draw the impedce and voltage triangles for above 3 condns. (6m)

ec'10

⑤. With usual notations, prove that power consumed in a RL or RC series ckt is VI cos θ (4m).

Dec'11

⑥. Draw the phasor diagm. for RL series ckt. and derive the expressions for real power. (6m)

June10.

⑦ For an RC series ckt (ac) (1) S.T current leads the applied voltage. ② obtain expression for power. ③ Draw the vector diagm. ④ Draw w/f for v, i and p. (10m)

Jan09.

⑧ Obtain an expression for power in a series RLC ckt (8m)

Jul08.

⑨ Obtain the form factor of a half rectified sine wave (5m)

⑩ Derive expressions for impedance, phase angle and power in R-L-C series ckt energized by sinus. volt. (6m)

⑪ Define ⓐ Active power ⓑ Reactive power ⓒ Apparent power in ac ckts. mention their units. (6m)

⑫. S.T. avg. power in a pure inductance with a sinusoidal voltage is zero. (5m)

⑬ Define and explain the significance of p.f in ac systems (6m)

(14) Derive the relation betn. voltage & current in series

Vector Representation of an altg. quantity.
(phasor)

An ~~altg~~ sinusoidal. voltage or currt. with sine waveform can be represented by a phasor rotating in ACW direction, as shown in fig. The altg voltage can be represented ~~when~~ by a vector when:

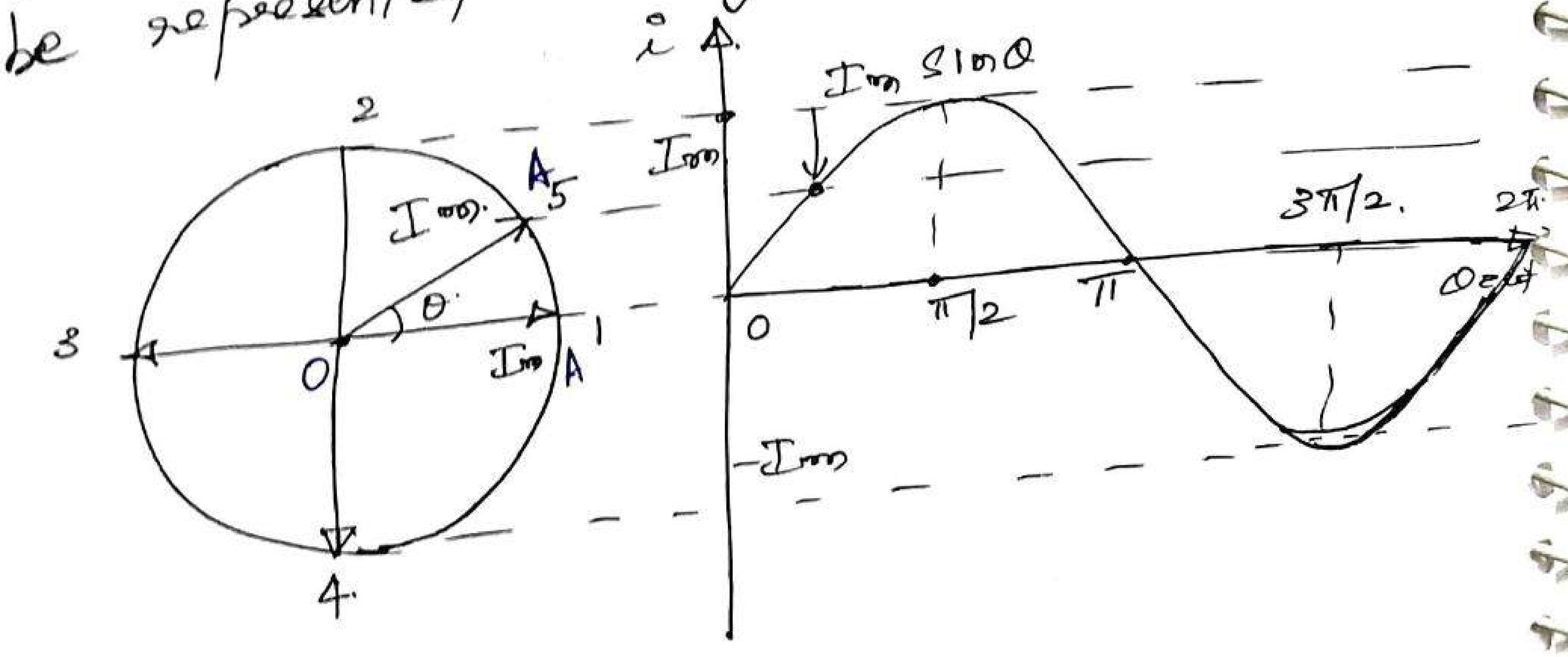
(1) The length of the phasor is equal to the maxm value of the altg. qty.

(2) It rotates with the same angular velocity as that of the altg. qty.

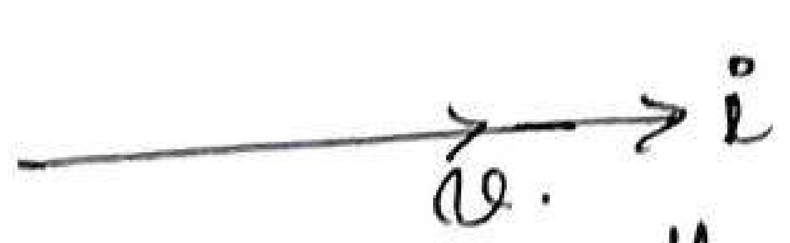
(3) Its projection on Y-~~axis~~ plane at any instant, represents the instantaneous value of the altg. qty.

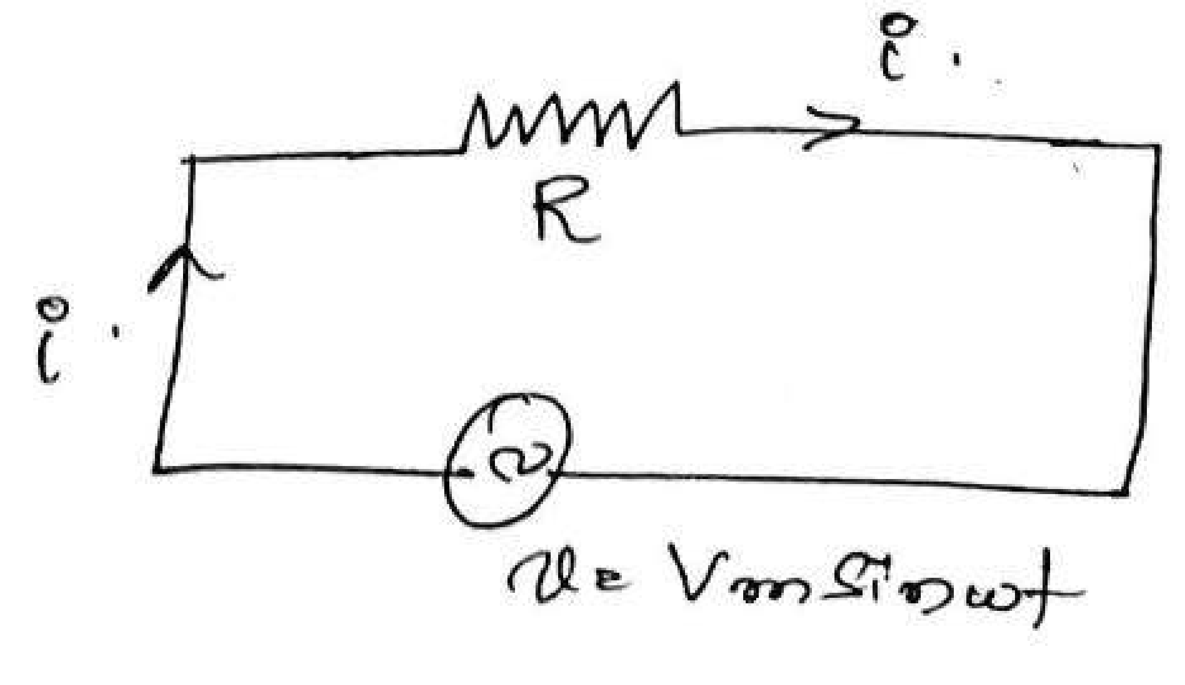
Consider a vector OA whose magnitude is equal to the maxm. value of the altg. currt Im, as shown. Let this vector rotate in the ACW direction with an angular velocity ω, same as that of the altg. currt. when it is in position 1, the projection of the vector OA on Y axis is zero, when $\theta = 0$. when the vector is rotated to posn-2, when $\theta = \frac{\pi}{2}$, its projection on Y axis is Im. when the vector is in posn-3, where $\theta = \pi$, its projection is zero. Again when $\theta = \frac{3\pi}{2}$, its projection is -Im. Again in posn.-(1), where θ = 2π, its projection on Y axis is zero.

At any posn. 5, at an angle θ from the reference axis, its projection is Im sin θ. When all the projected values of this vector on Y plane are plotted and the curve is traced, it gives a sine wave as shown in fig, whose equation is $i = I_m \sin\theta$, which is also the equation for a sinusoidal current. Hence, this shows that a sinusoidal qty can be represented by rotating phasor.



AC flowing through a pure resistor





consider a ckt with a pure resistance R only connected across an altg. voltage of

$v = V_m \sin\omega t$ - (1) as shown in fig.

As a result, an altg current 'i' will flow through the ckt. The applied voltage has to supply the ohmic voltage drop only across R.

$\therefore \quad v = iR$

$V_m \sin\omega t = iR$

$\therefore \quad i = \frac{V_m \sin\omega t}{R} = \frac{V_m}{R} \sin\omega t$ ②

The value of altg. current. i is maxm. when $\sin\omega t = 1$. ie ωt 90°

ie $i = I_m = \frac{V_m}{R}(1) = \frac{V_m}{R}$ -(3)

substg. this value of I_m in (2), we get

$i = I_m \sin\omega t$ - (4).

Comparing equns. (1) & (4), it is seen that the voltage and current v & i are inphase with each other. They are shown in the wave diagm and by the vectors in fig. below.

The instantaneous power consumed in the ckt,

$p = vi$.

$p = (V_m \sin\omega t)(I_m \sin\omega t)$

$$= V_m I_m \sin^2 \omega t.$$

$$= V_m I_m \frac{(1 - \cos 2\omega t)}{2}.$$

$$p = \frac{V_m I_m}{2} - \frac{V_m I_m}{2} \cos 2\omega t.$$

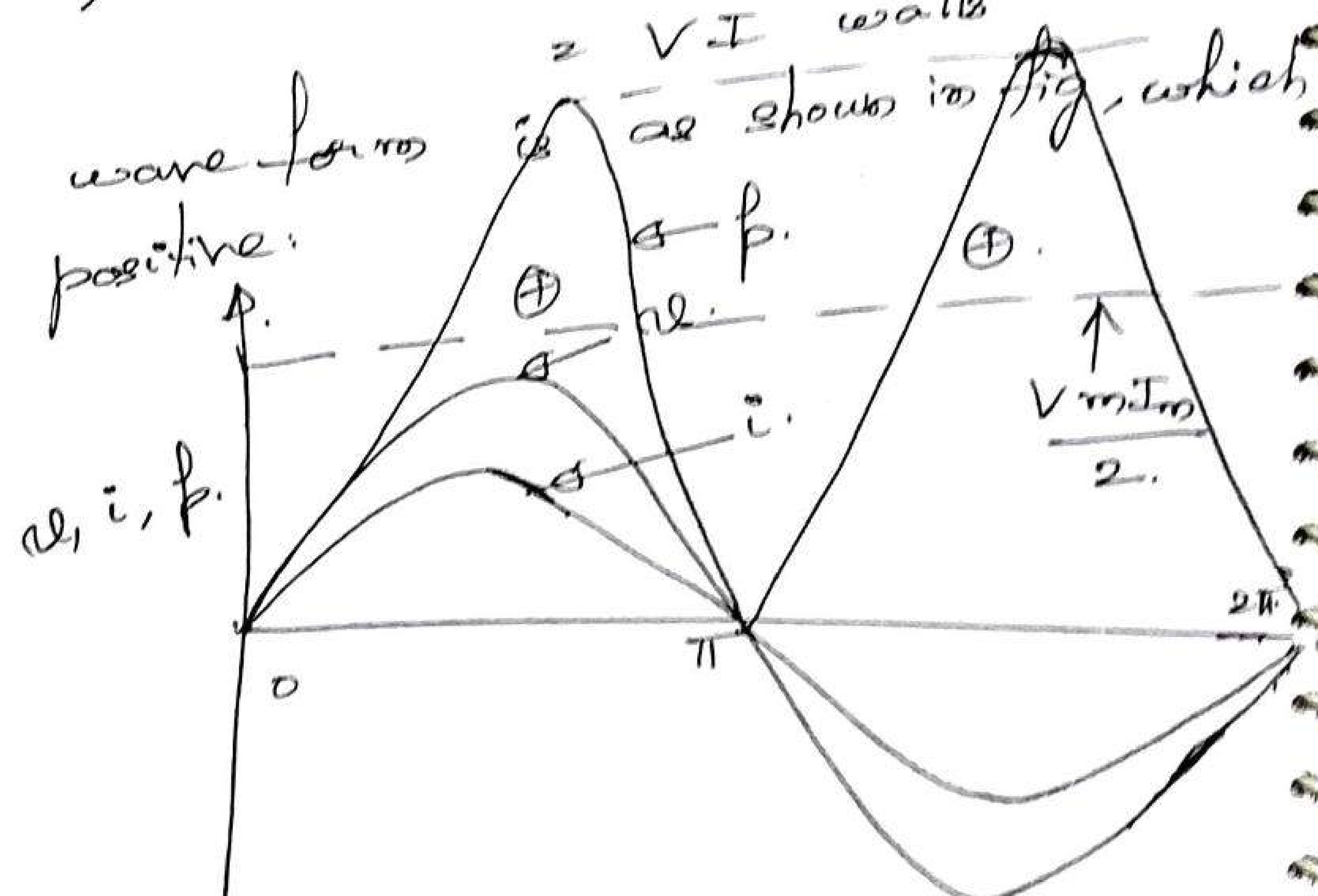
This power eqn. consists of a constant part $\frac{V_m I_m}{2}$ and a fluctuating part $\frac{V_m I_m}{2} \cos 2\omega t$ of frequency double that of voltage and current waves. The average value of $\frac{V_m I_m}{2} \cos 2\omega t$ over a complete cycle is zero.

∴ Power for the complete cycle is $P = \frac{V_m I_m}{2}$

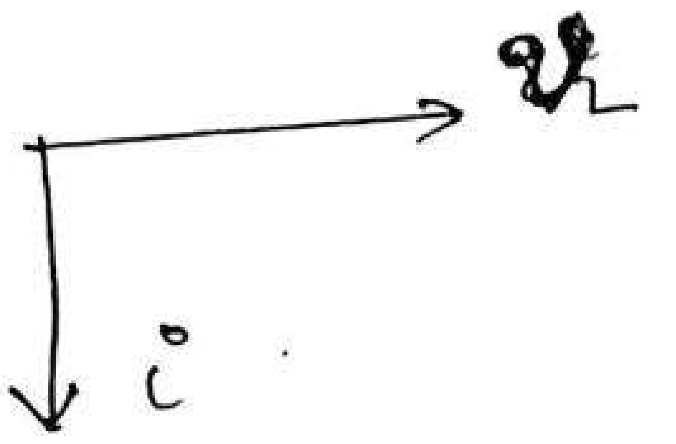
∴ Power consumed in pure resistor $P = \frac{V_m}{\sqrt{2}} \frac{I_m}{\sqrt{2}} = V_{rms} I_{rms}$

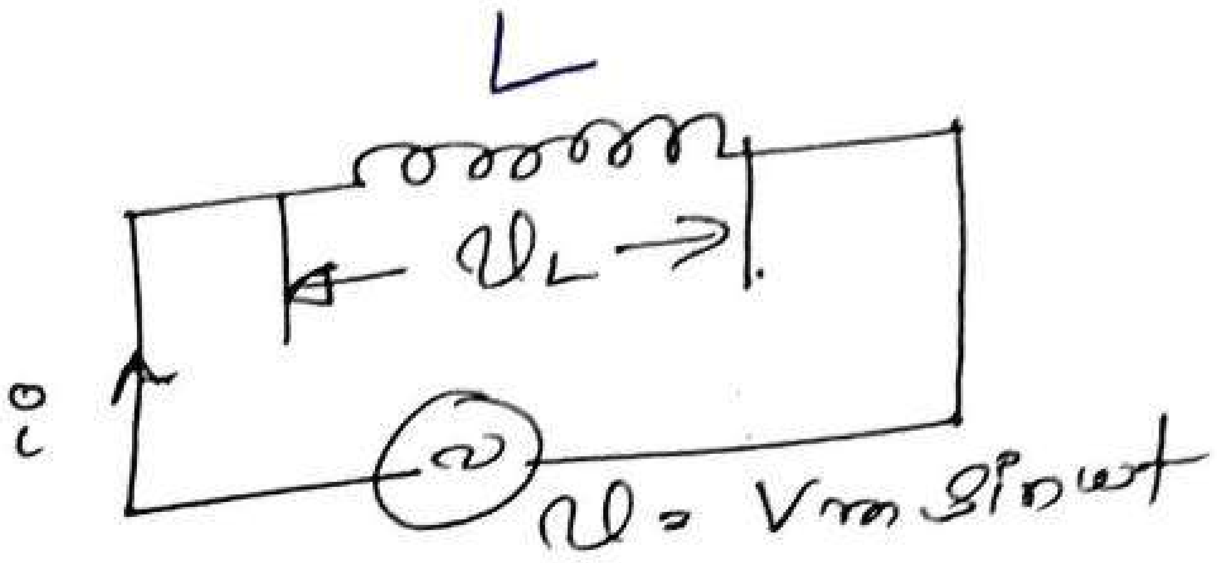
$= VI$ watts

The power wave form is as shown in fig, which is always positive.



AC flowing through a pure inductor.





Consider a coil of pure inductance of 'L' henrys across which an altg. voltage

$v = V_m \sin\omega t$ —(1) is applied as shown.

An altg curnt. i flows through the ckt, which produces an altg. flux linking the coil. A back emf is produced due to self inductance of the coil and the applied voltage has to overcome only this self induced emf since there is no ohe ohmic drop in a pure inductor.

i.e, $v = L \frac{di}{dt}$

$$V_m \sin\omega t = L \frac{di}{dt}$$

$$di = \frac{V_m}{L} \sin\omega t \; dt$$

Integrating both sides, $\int di = \int \frac{V_m}{L} \sin\omega t \, dt$

$$i = \frac{V_m}{L}\left(\frac{-\cos\omega t}{\omega}\right).$$

$$= +\frac{V_m}{\omega L}\left(-\cos\omega t\right).$$

$$i = \frac{V_m}{\omega L}\sin\left(\omega t - \frac{\pi}{2}\right) \quad -(2)$$

The value of i maxm. when $\sin\left(\omega t - \frac{\pi}{2}\right)$ is max $= 1$.

$$\therefore \quad i = I_m = \frac{V_m}{\omega L}(1). = \frac{V_m}{X_L.} \quad -(3)$$

when $X_L = \omega L = 2\pi f L.$ is called the inductive reactance, which is expressed in Ω.

Substg. (3) in (2),

$$i = I_m \sin\left(\omega t - \frac{\pi}{2}\right) \quad -(4).$$

By observing equating (1) & (4) for v & i, we find that the current in ~~an~~ pure inductor lags behind the applied voltage by $\frac{\pi}{2}$ or 90°. The waveforms and vectorial representations are shown in fig.

The instantaneous power $p = vi$

$$= V_m \sin\omega t \; I_m \left(\sin\left(\omega t - \frac{\pi}{2}\right)\right)$$

$$= V_m \sin\omega t \; I_m \left(-\cos\omega t\right)$$

$$p. = -\frac{V_m I_m}{2.}\sin 2\omega t$$

$$p = -\frac{V_m I_m}{2} \sin 2\omega t$$

Hence the power equation shows that power wave is a sine wave of frequency double that of voltage and curnt. waves and its maxm. value is $\frac{V_m I_m}{2}$.

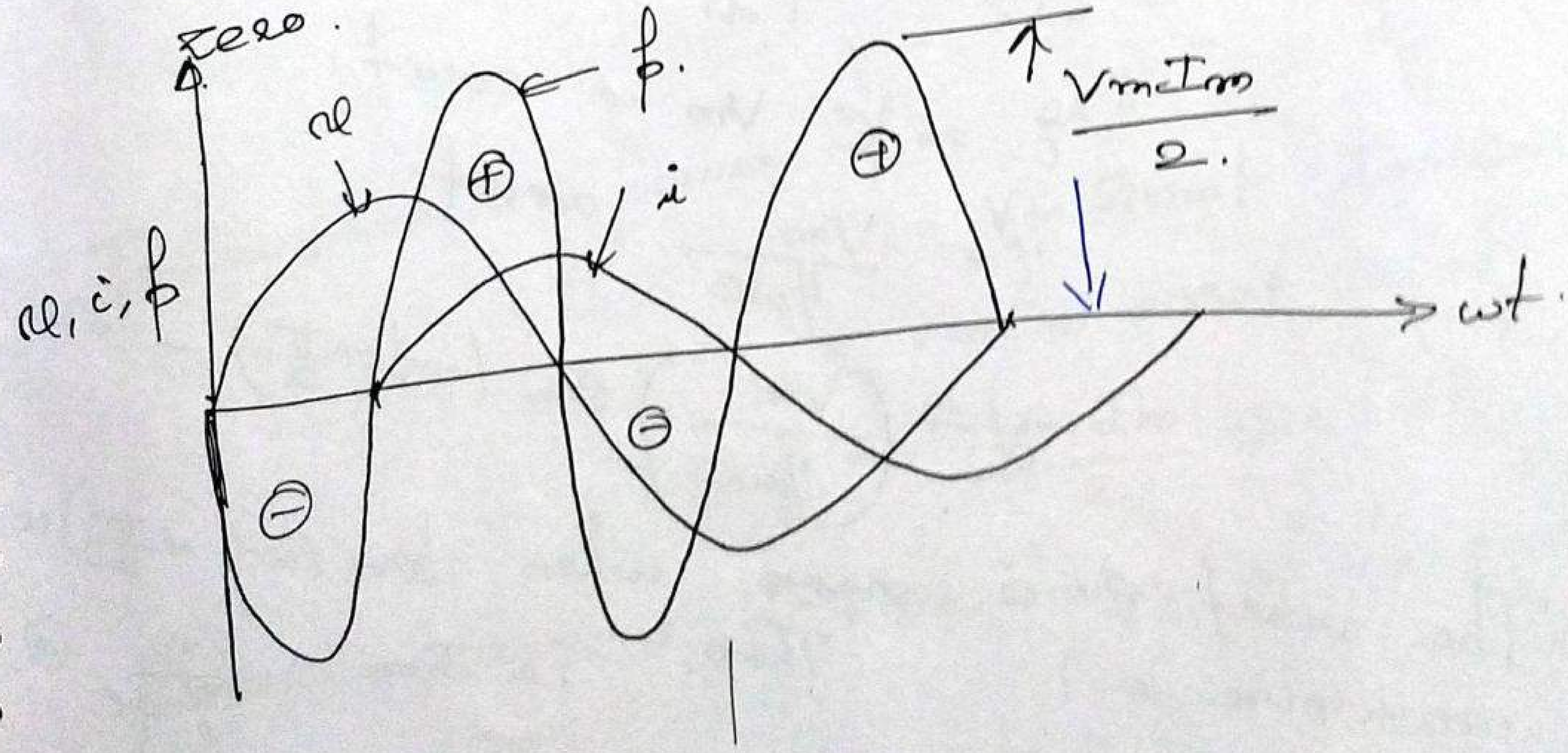
Power for the whole cycle = $p = -\frac{V_m I_m}{2}\int_0^{2\pi} \sin 2\omega t \, \cancel{dt} \, d\omega t$

∴ Average power $= -\frac{V_m I_m}{2}\left[\frac{\cos 2\omega t}{2\omega}\right]_0^{2\pi}$

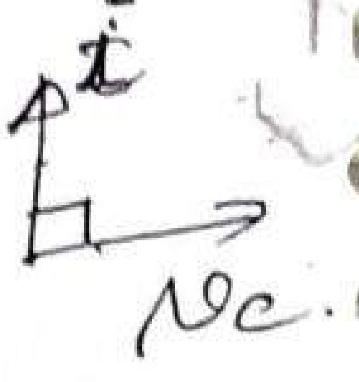
$$= \frac{V_m I_m}{4\omega}\left[\cos 4\pi - \cos 0\right].$$

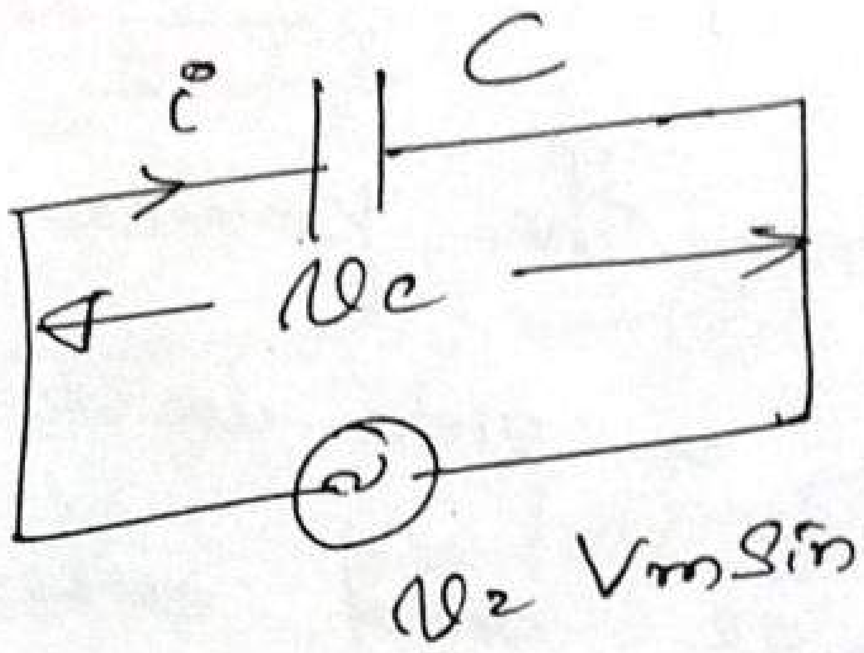
$$= \frac{V_m I_m}{4\omega}(1-1) = 0.$$

Hence the power absorbed in a pure inductor is zero.



AC through a pure Capacitor





Consider a pure capacitor of capacitance 'C' farads connected across a voltage source of

$$v = V_m \sin\omega t \quad — ①.$$

when an altg. voltage is applied across the plate of a capr., the capr. is charged first in one direction and then in the opposite direction. $q = Cv$.

Instantaneous charge on the plates $= C V_m \sin\omega t$

Capacitor current is $i = \frac{dq}{dt}$.

$$= \frac{d}{dt}(C V_m \sin\omega t)$$

$$i = C V_m \omega \cos\omega t.$$

$$i = \frac{V_m}{1/\omega C} \cos\omega t.$$

$$i = \left(\frac{V_m}{1/\omega C}\right) \sin\left(\omega t + \frac{\pi}{2}\right) — ②$$

The current i is maxm. when $\sin\left(\omega t + \frac{\pi}{2}\right)$ is maximum. $= 1$. Then, $i = I_m = \frac{V_m}{1/\omega C}$ ③

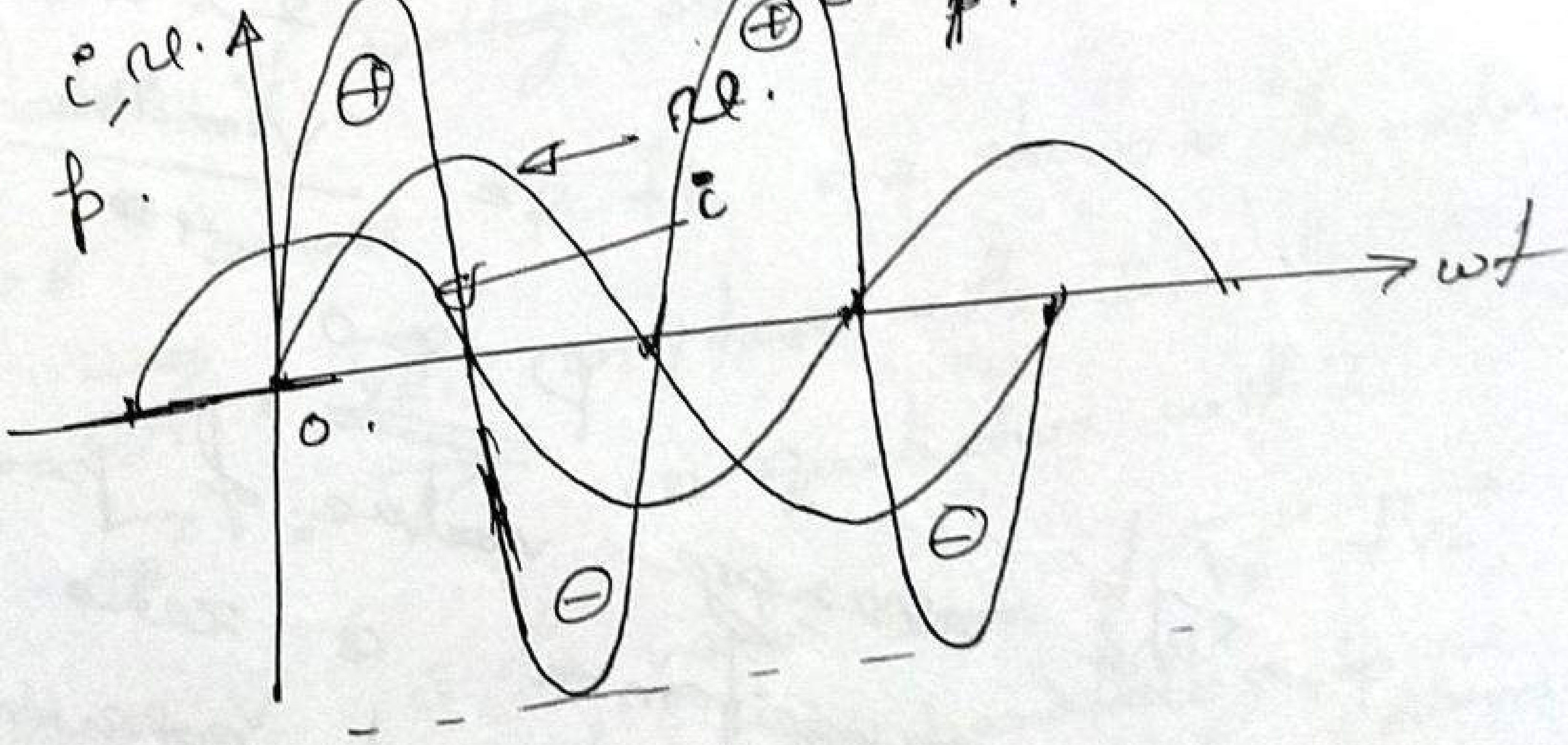
Substg (3) in (2), we get

$$i = I_m \sin\left(\omega t + \frac{\pi}{2}\right) \quad -(4.)$$

where $I_m = \dfrac{V_m}{1/\omega C} = \dfrac{V_m}{X_C}$.

where $X_C = \dfrac{1}{\omega C} = \dfrac{1}{2\pi f C}$ is the capacitive reactance in Ωs.

Comparing equns. (4) & (1), we see that the current in a pure capacitor leads the voltage by 90° or $\frac{\pi}{2}$ rads. The wave diagm. & vectors are as shown.



Instantaneous power $p = vi$

$$= V_m \sin\omega t \; I_m \sin\left(\omega t + \frac{\pi}{2}\right)$$

$$= V_m I_m \cos\omega t \sin\omega t$$

$$p = \frac{V_m I_m}{2} \sin 2\omega t$$

Power wave is a sine wave of double frequency that of voltage and curr. waves and its maximum value is $\frac{V_m I_m}{2}$.

The average power for the complete cycle

$$P = \int_0^{2\pi} \frac{V_m I_m}{2} \sin 2\omega t \, d\omega t$$

$$= \frac{V_m I_m}{2} \int_0^{2\pi} \sin 2\omega t \, d\omega t$$

$$\frac{V_m I_m}{2} \left[\frac{\cos 2\omega t}{2} \right]_0^{2\pi}$$

$$= -\frac{V_m I_m}{2 \times 2} \left[\cos 4\pi - \cos 0 \right]$$

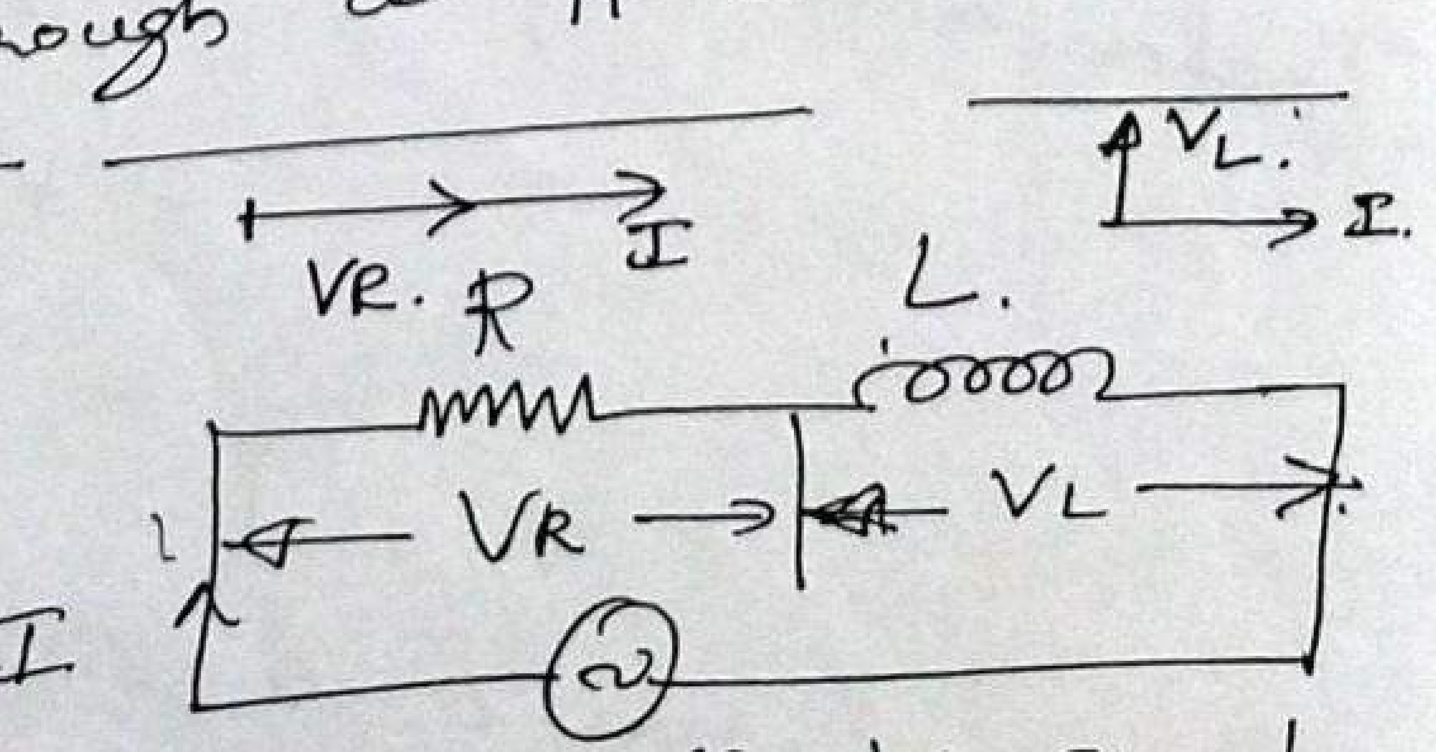
$$= -\frac{V_m I_m}{4} (1-1) = \underline{\underline{0}}$$

$$\underline{\underline{P = 0}}$$

∴ The average value of power absorbed in a pure capacitance is zero. Hence a pure capacitor does not consume any power.

A C flowing through a R-L series ckt

Consider an AC ckt containing a pure inductance of 'L'



Consider an A c ckt containing a pure resist R Ω and a pure inductance of L Henrys connected in series, across an alternating voltage source of v volts.

$v = V_m \sin\omega t$. — (1) ~~let~~

Let V = Rms value of the applied voltage

I = Rms value of the current flowing through the ckt.

Then, R.m.s value of voltage drop across $R = V_R = IR$.

Rms value of voltage drop across $L = V_L = I X_L$.

The voltage drops across R & L are shown in the vector diagm, where $\overrightarrow{OA} = \overrightarrow{V_R}$. in phase with I.

$\overrightarrow{AB} = \overrightarrow{V_L}$ in quadrature with I.

The applied voltage V is the vector sum of $\overrightarrow{V_R}$ & $\overrightarrow{V_L}$, which is given by the diagonal of the parallelogram as shown.

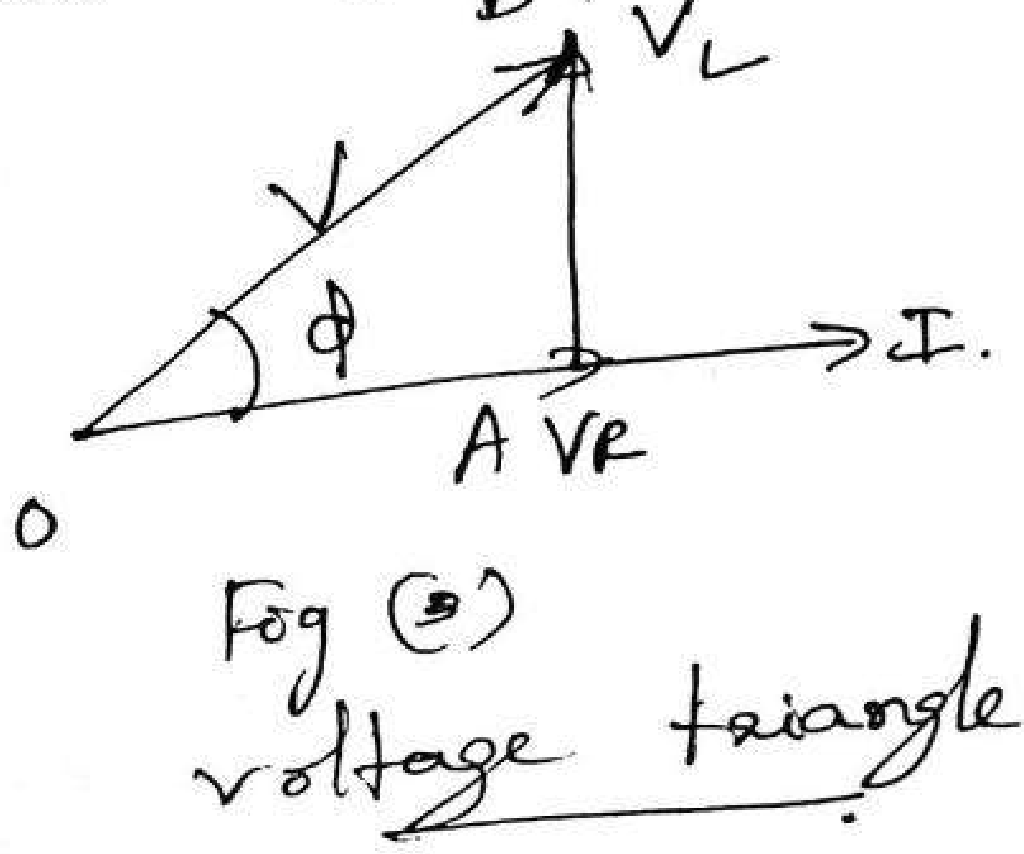


Fig (3)
voltage triangle.

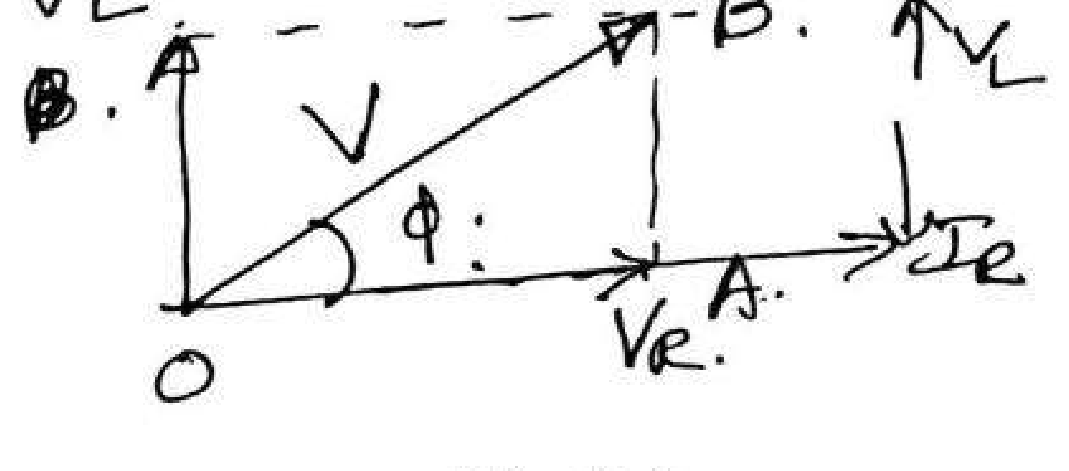


Fig (2)
vector diagm.

From fig (2) & (3), $V^2 = V_R^2 + V_L^2$

$$V^2 = (IR)^2 + (IX_L)^2$$

$$V^2 = I^2(R^2 + X_L^2)$$

$$I = \frac{V}{\sqrt{R^2 + X_L^2}}$$

$$I = \frac{V}{Z} \quad \text{where } Z = \sqrt{R^2 + X_L^2}$$

The quantity $\sqrt{R^2 + X_L^2}$ is known as the impedance Z of the ckt. and it is the opposition offered to the flow of current and is measured in Ω.

From the voltage triangle, $\tan\phi = \frac{V_L}{V_R} = \frac{IX_L}{IR}$

$$\tan\phi = \frac{X_L}{R}$$

$$\phi = \tan^{-1}\left(\frac{X_L}{R}\right) \text{ or } \phi = \tan^{-1}\left(\frac{V_L}{V_R}\right)$$

By observing the vectors of V and I, we see that the current I lags behind the voltage V by ∠φ. Hence the equation for current is, $i = I_m \sin(\omega t - \phi)$. The waveforms are as shown in fig. (5). The voltage triangle and impedance Δle are as shown in fig (4)

$I_m = \frac{V_m}{Z}$

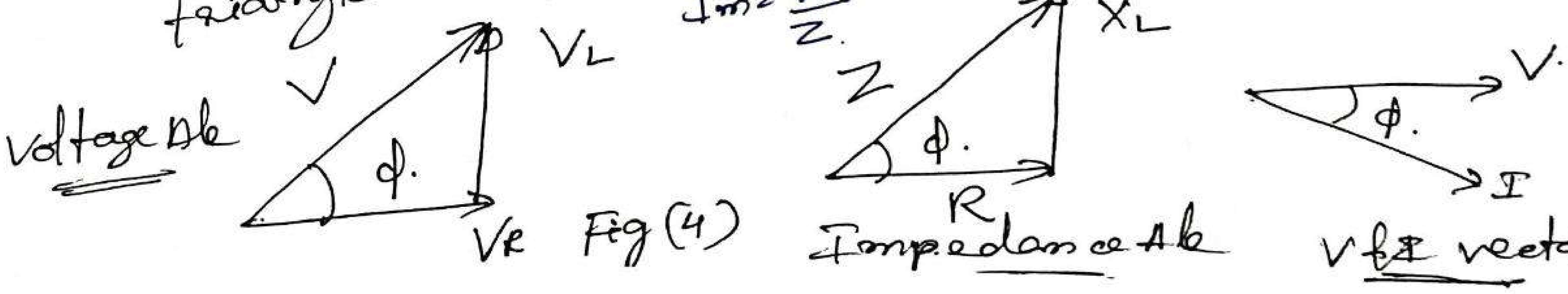


Fig (4) Impedance Δle V & I vectors

$2\sin A \sin B = \cos(A-B) - \cos(A+B)$

Instantaneous power $p = vi$

$$= (V_m \sin\omega t)\,(I_m \sin(\omega t - \phi)).$$

$$= V_m I_m \left(\sin\omega t \ \sin(\omega t - \phi)\right)$$

$$= \frac{V_m I_m}{2}\left(\cos(\omega t - \omega t + \phi) - \cos(\omega t + \omega t - \phi)\right)$$

$$= \frac{V_m I_m}{2}\left[\cos\phi - \cos(2\omega t - \phi)\right].$$

The power consists of two parts:

(1) Constant part $\frac{V_m I_m}{2}\cos\phi$ which contributes to the real power

(2) Sinusoidally varying part $\frac{V_m I_m}{2}(\cos(2\omega t - \phi))$ whose frequency is twice that of voltage and the current and the average power over a complete cycle is zero.

$\therefore$ Average power consumed, $P = \frac{V_m I_m}{2}\cos\phi.$

$$= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}}\cos\phi.$$

$$P = VI\cos\phi.$$

where $\cos\phi$ is the power factor of the ckt.

The power is as shown in fig(5).

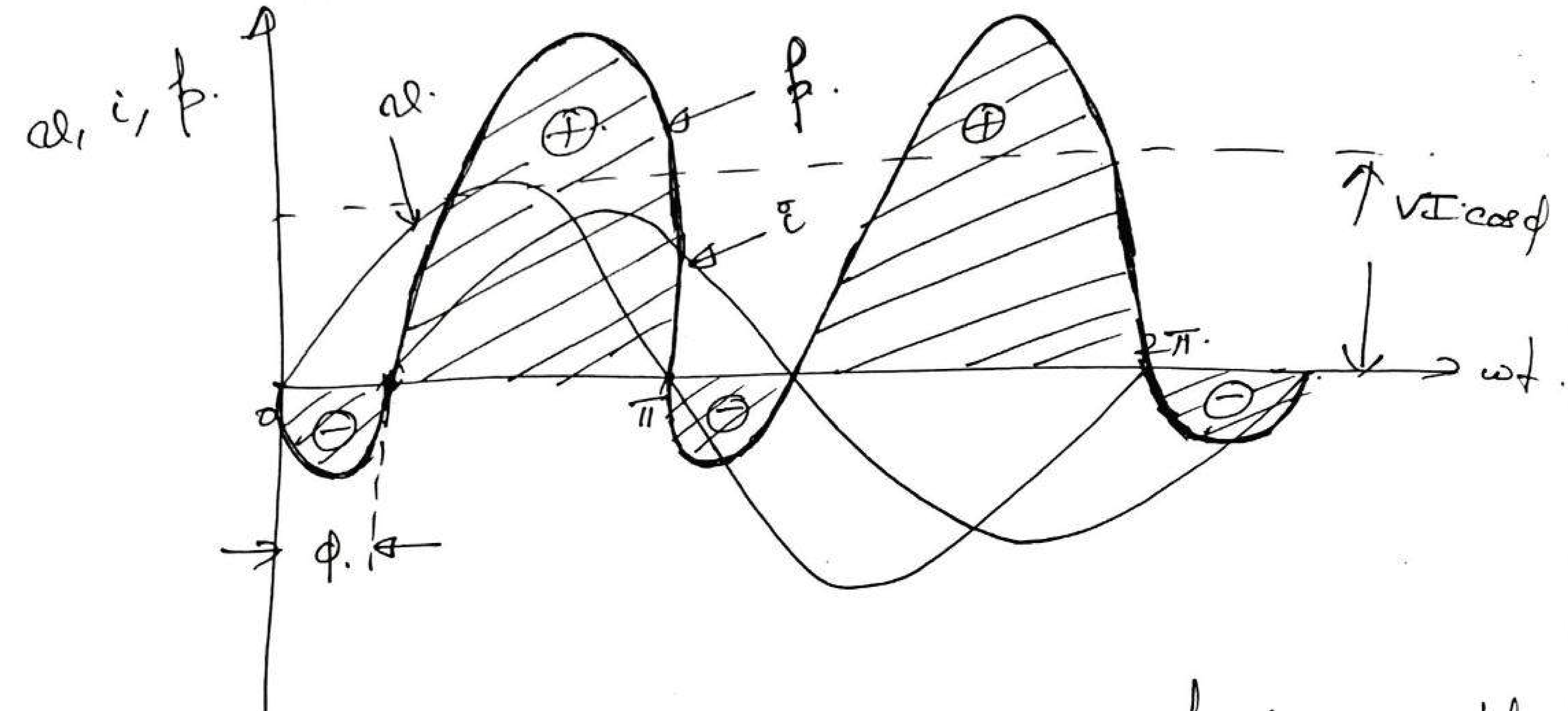
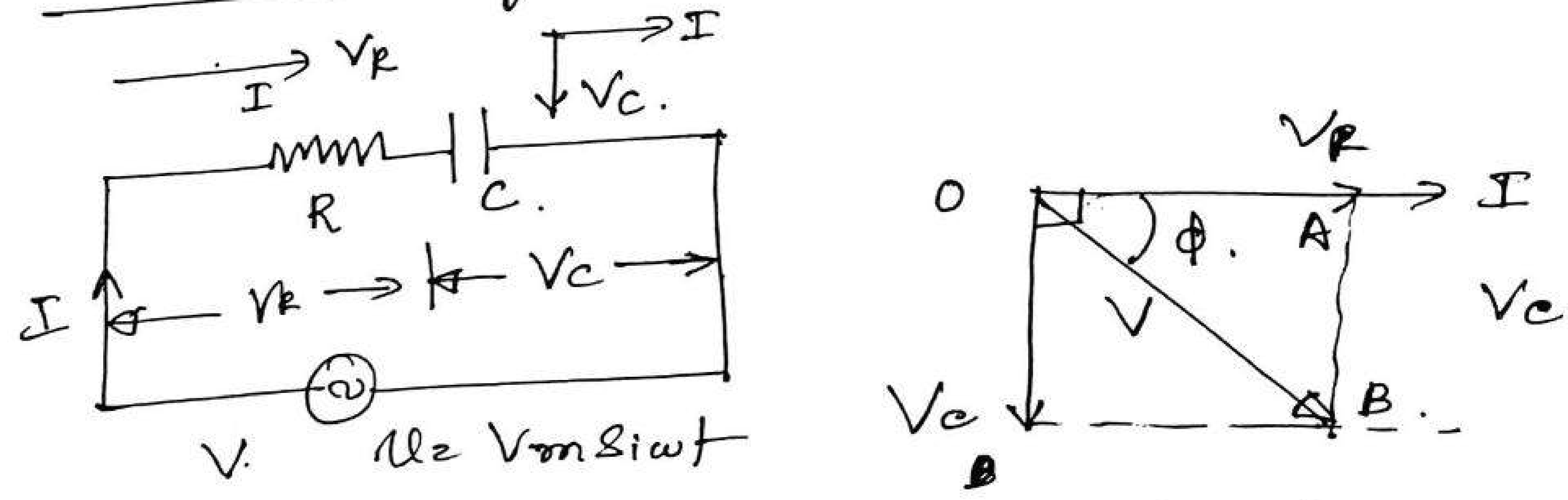


Fig (5) . v, i, and power w/fs

A C flowing through a series R-C ckt.



vector diagm.

Fig (1)

voltage triangle

Impedance Δle

Fig (2)

Consider an ac ckt. with resist R and capacitce C farads connected across an altg. voltage of $v = V_m \sin\omega t$.

Let V = Rms value of voltage.

I = Rms value of current.

$V_R = IR$ = Rms value of voltage drop a/s R.

$V_c = IX_c$ = Rms value of voltage drop a/s C.

V_R is inphase with I and V_c leads I by 90°.

The vectors are shown in vector diagm. From the vector diagm;

$$OA^2 + AB^2 = OB^2$$

$$= V_R^2 + V_c^2 = V^2.$$

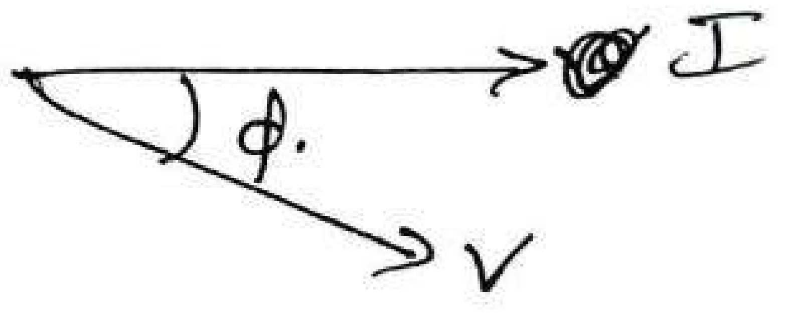
$$(IR)^2 + (IX_c)^2 = V^2.$$

$$I = \frac{V}{\sqrt{R^2 + X_c^2}} = \frac{V}{Z}.$$

where $Z = \sqrt{R^2 + X_c^2}$ is the impedance of the ckt.

The voltage Δle and impedance Δle are shown in fig (2). The voltage & current vectors are shown below. By observing them, we see that the current leads voltage V by ∠φ.

where $\phi = \tan^{-1}\left(\frac{V_c}{V_R}\right)$



$$\phi = \tan^{-1}\left(\frac{V_C}{V_R}\right)$$

$$= \tan^{-1}\left(\frac{IX_C}{IR}\right)$$

$$\phi. = \tan^{-1}\left(\frac{X_C}{R}\right)$$

Hence, the equation for current i is given by,

$i = I_m \sin(\omega t + \phi)$ where $I_m = \frac{V_m}{Z}$

The waveforms of voltage, currt. are shown in wave diagm. in fig (3).

Ins~~tantan~~teneous power $p = vi$

$= V_m \sin\omega t \; I_m \sin(\omega t + \phi)$

$= V_m I_m \left(\sin\omega t \sin(\omega t + \phi)\right)$

$= \frac{V_m I_m}{2}\left(\cos(\omega t - \omega t - \phi) - \cos(\omega t + \omega t + \phi)\right)$

$= \frac{V_m I_m}{2}\left(\cos\phi - \cos(2\omega t + \phi)\right)$

The power has two parts:

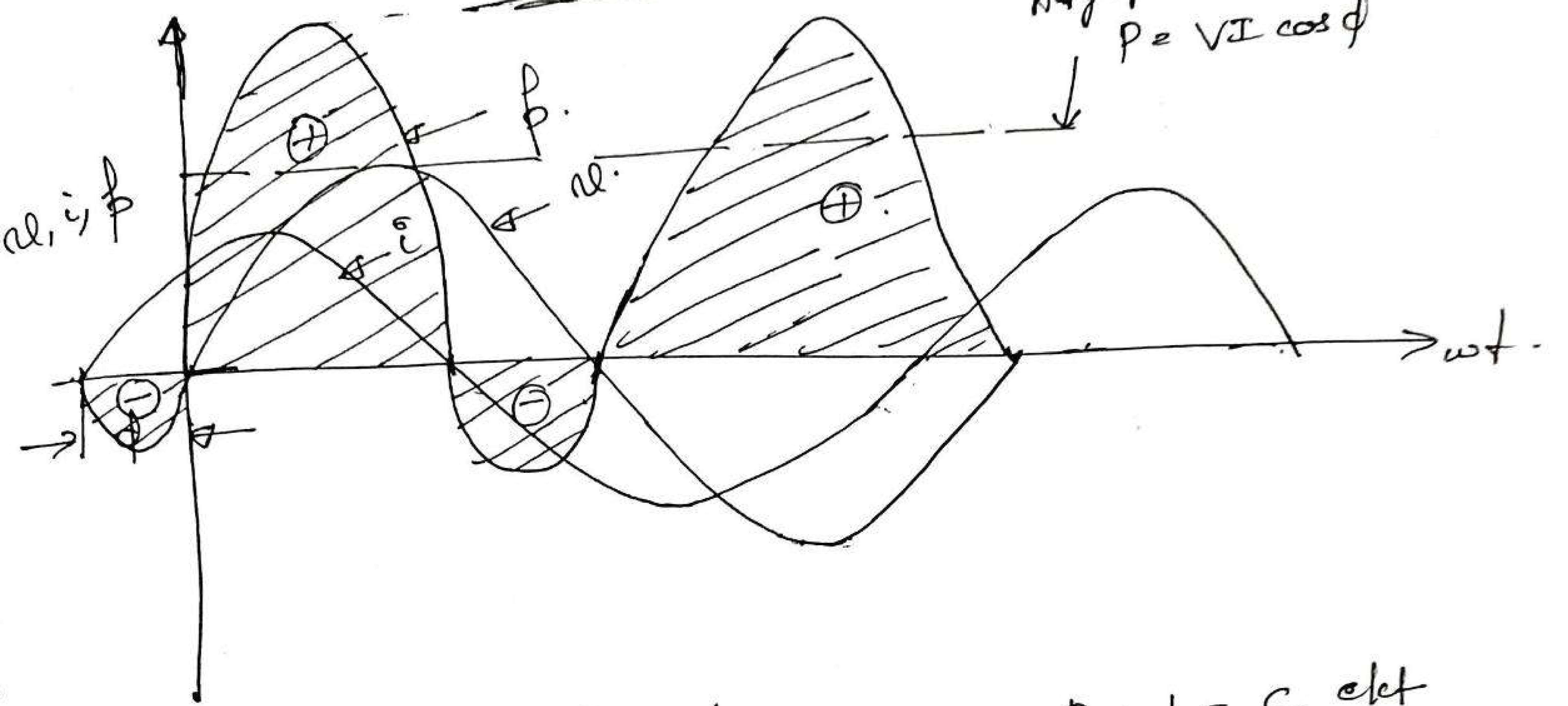
(1) Constant part $\frac{V_m I_m}{2}\cos\phi$. contributes to real power

(2) Sinusoidally varying part $\frac{V_m I_m}{2}\cos(2\omega t + \phi)$ whose frequency is twice that of the voltage and the currt. and the avg. value over a complete cycle is zero.

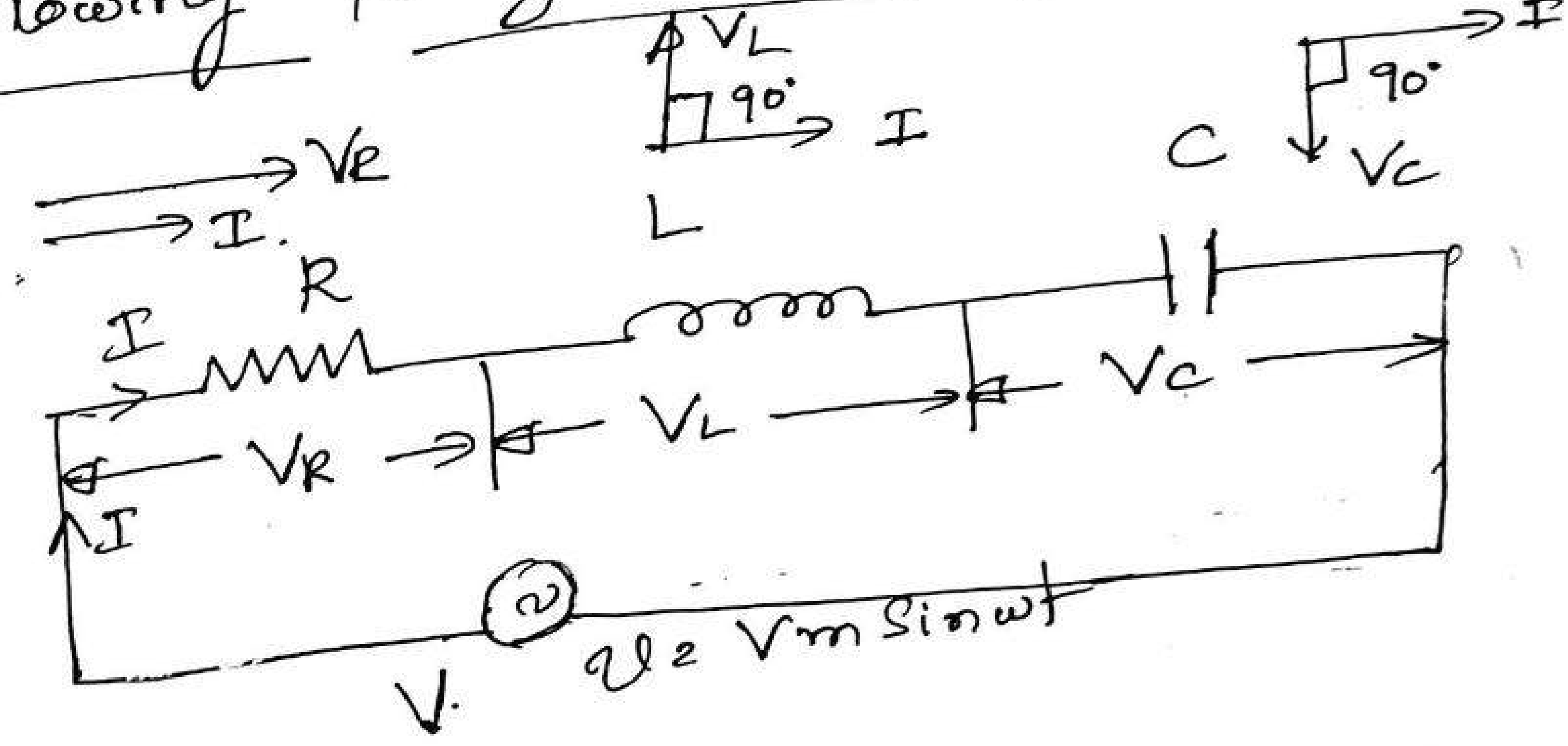
ie $\int_0^{2\pi} \frac{V_m I_m}{2}\cos(2\omega t + \phi) = 0.$

∴ Avg. power $P = \frac{V_m I_m}{2} \cos\phi = \frac{V_m}{\sqrt{2}} \frac{I_m}{\sqrt{2}} \cos\phi$

$$P = VI\cos\phi$$



AC flowing through a series R– L– C ckt



Consider an a.c ckt. containing resist R-r, inductance L H. and capacitance C farads all connected in series across an altg. voltage source of $v = V_m \sin\omega t$. Let V = Rms value of applied voltage

I = Rms value of current

$V_R = IR$ → R ms value of voltage drop across R.

$V_L = IX_L$ ⇒ Rms value of voltage drop across L.

$V_C = IX_C$ ⇒ Rms value of voltage drop across C.

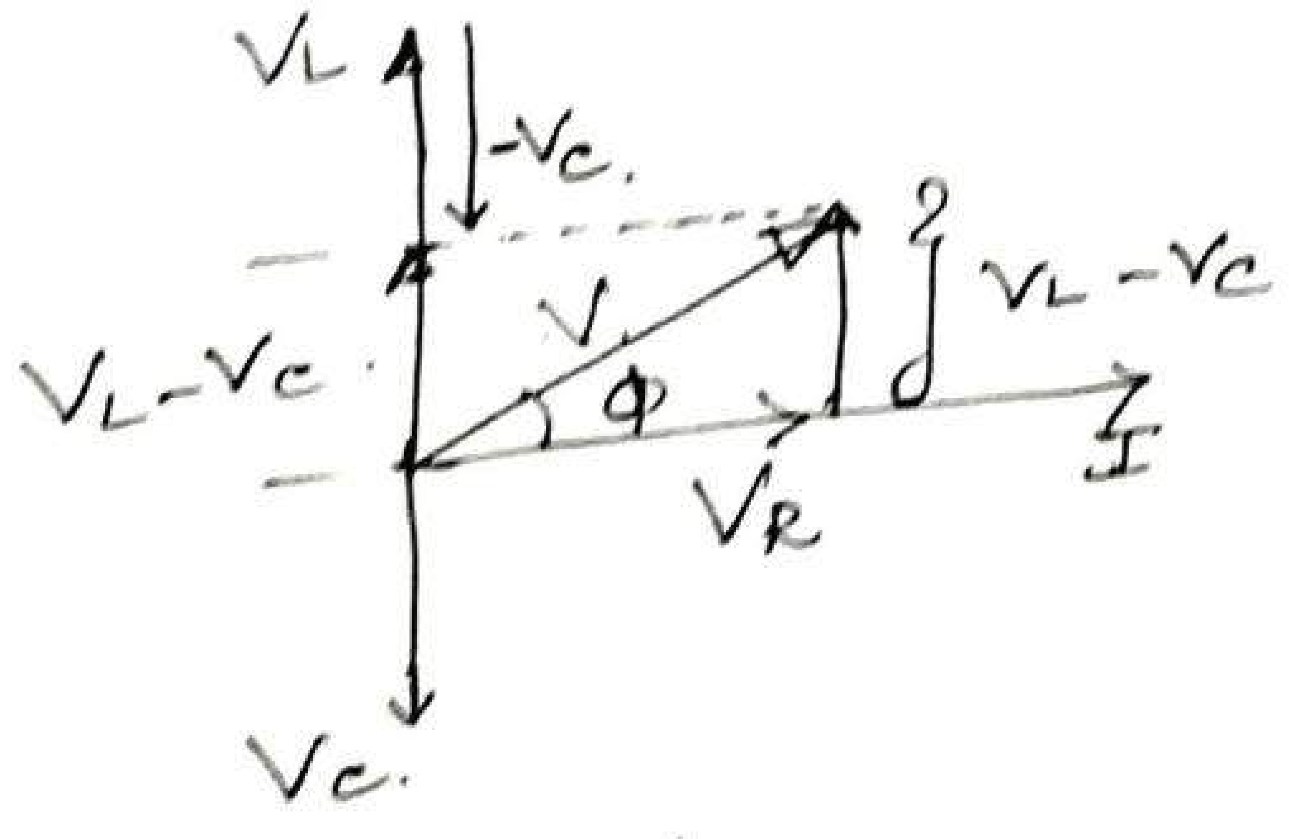
V_R is in phase with I. V_L leads I by 90° and V_C lags I by 90°. The vector diagram and hence the voltage triangle, impedance Δle are shown below.

Case 1 : when $X_L > X_C$.

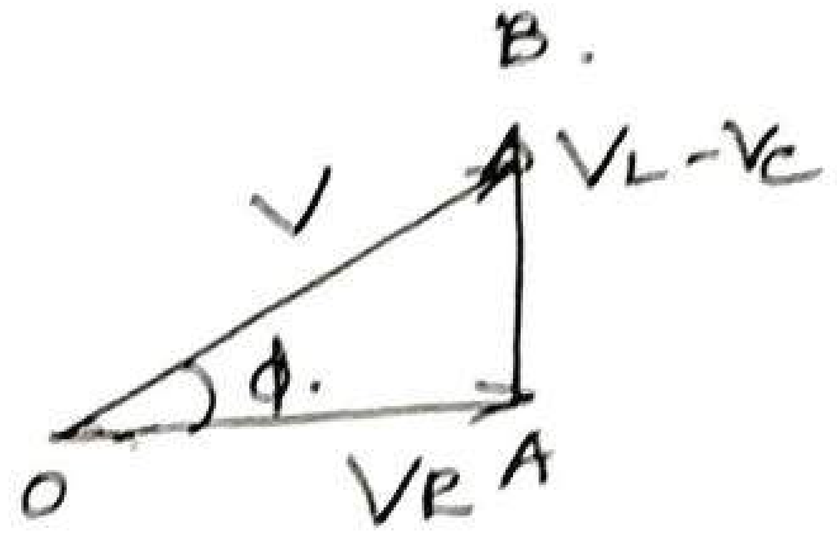
$$I X_L > I X_C$$

$$V_L > V_C.$$

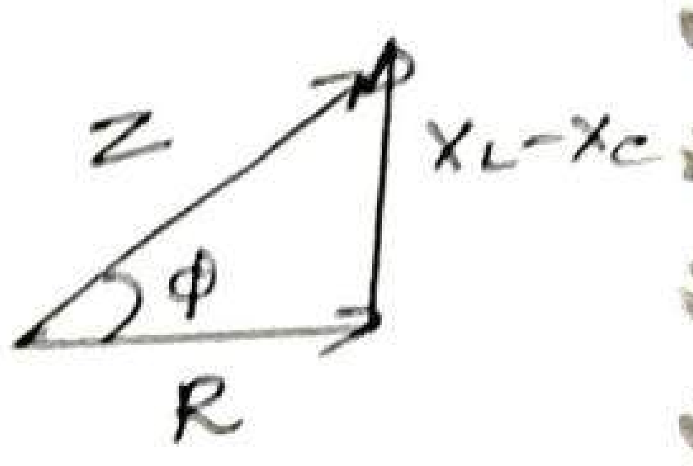
ie when $X_L > X_C$, the inductive voltage drop V_L is greater than the capacitive voltage drop, and hence the V.D is as shown below.



vector diagram



voltage Δle



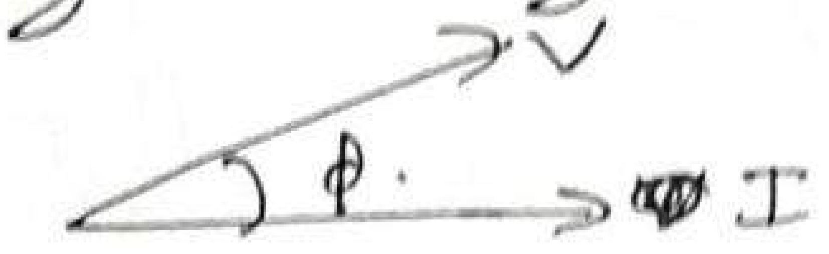
Impedance Δle

From the voltage Δle,
$$V^2 = V_R^2 + (V_L - V_C)^2$$
$$= (IR)^2 + I^2(X_L - X_C)^2$$

$$I = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$$

$$I = \frac{V}{Z}$$

The vectors for V and I are as shown below. It is observed that the current I lags the voltage V by ∠φ.



∴ The equation for currt. is,

$$i = I_m \sin(\omega t - \phi)$$

where $\phi = \tan^{-1}\left(\frac{V_L - V_C}{V_R}\right) = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$.

Power consumed is, $\underline{P = VI\cos\phi}$. The ckt behaves as a series R-L ckt.

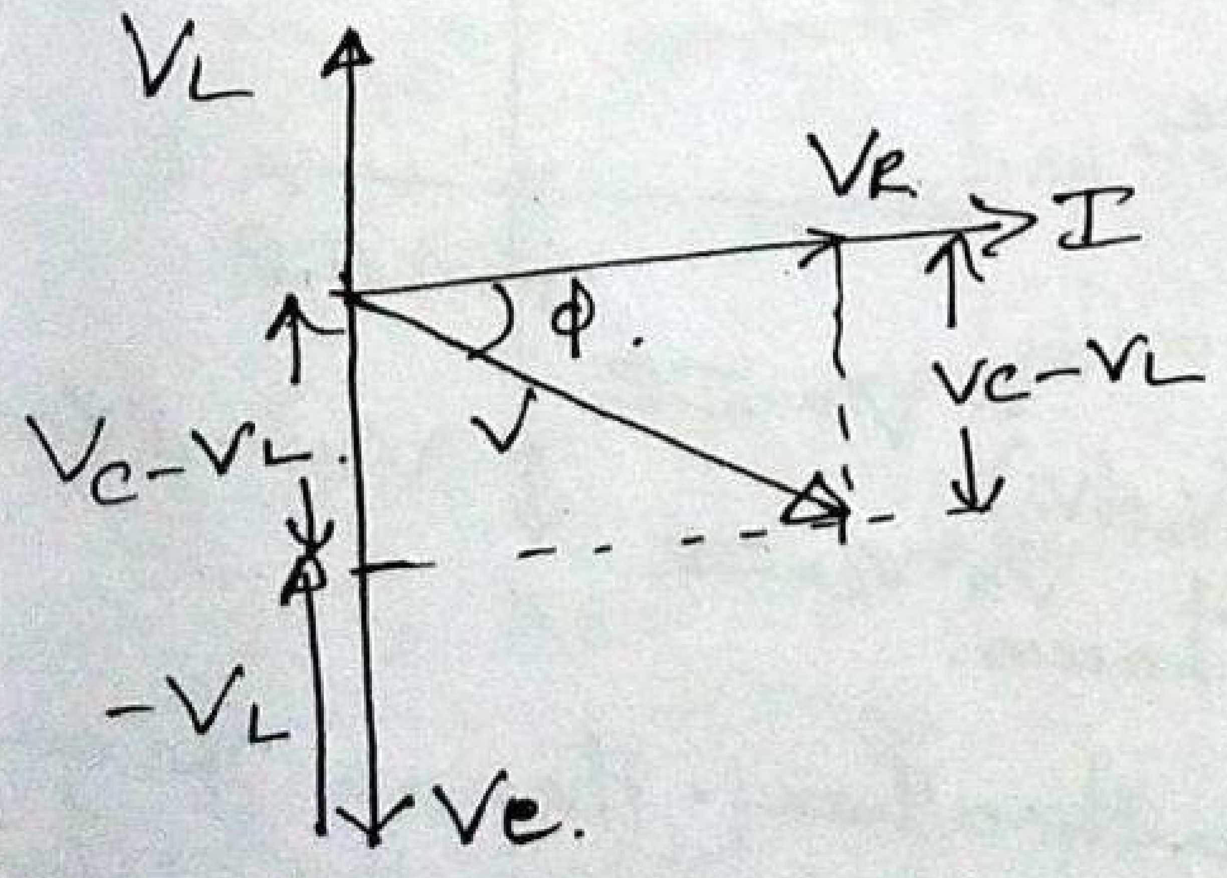
Case 2 when $X_L < X_C$.

when $X_L < X_C$,

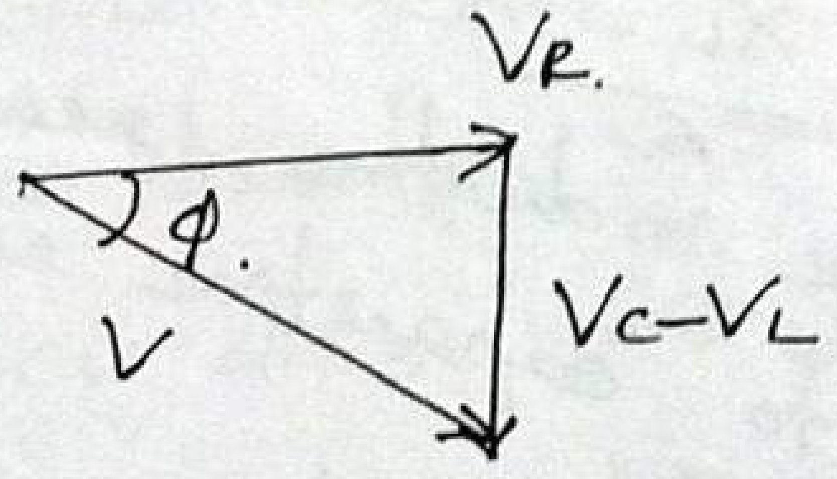
$$I X_L < I X_C$$

$$V_L < V_C.$$

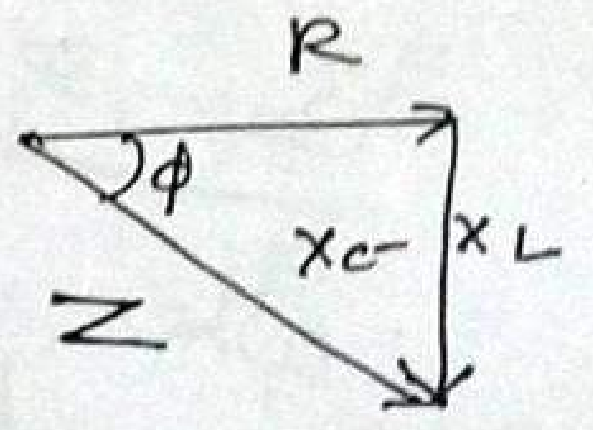
Hence the vector diagm., voltage Δle, impedance Δle are as shown.



vector diagm



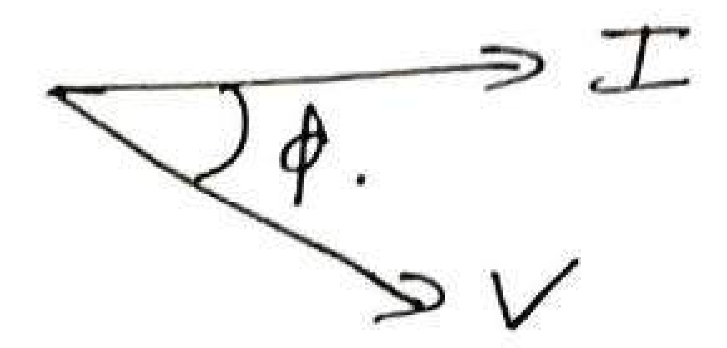
voltage Δle



Impedance Δle

The voltage and current vectors are as shown below. It is observed that the current leads the voltage by ∠φ. where $\phi = \tan^{-1}\left(\frac{V_C - V_L}{V_R}\right)$

$\phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right)$



From voltage Δle, we have

$$V^2 = V_R^2 + (V_C - V_L)^2$$

$$= (IR)^2 + (IX_C - IX_L)^2.$$

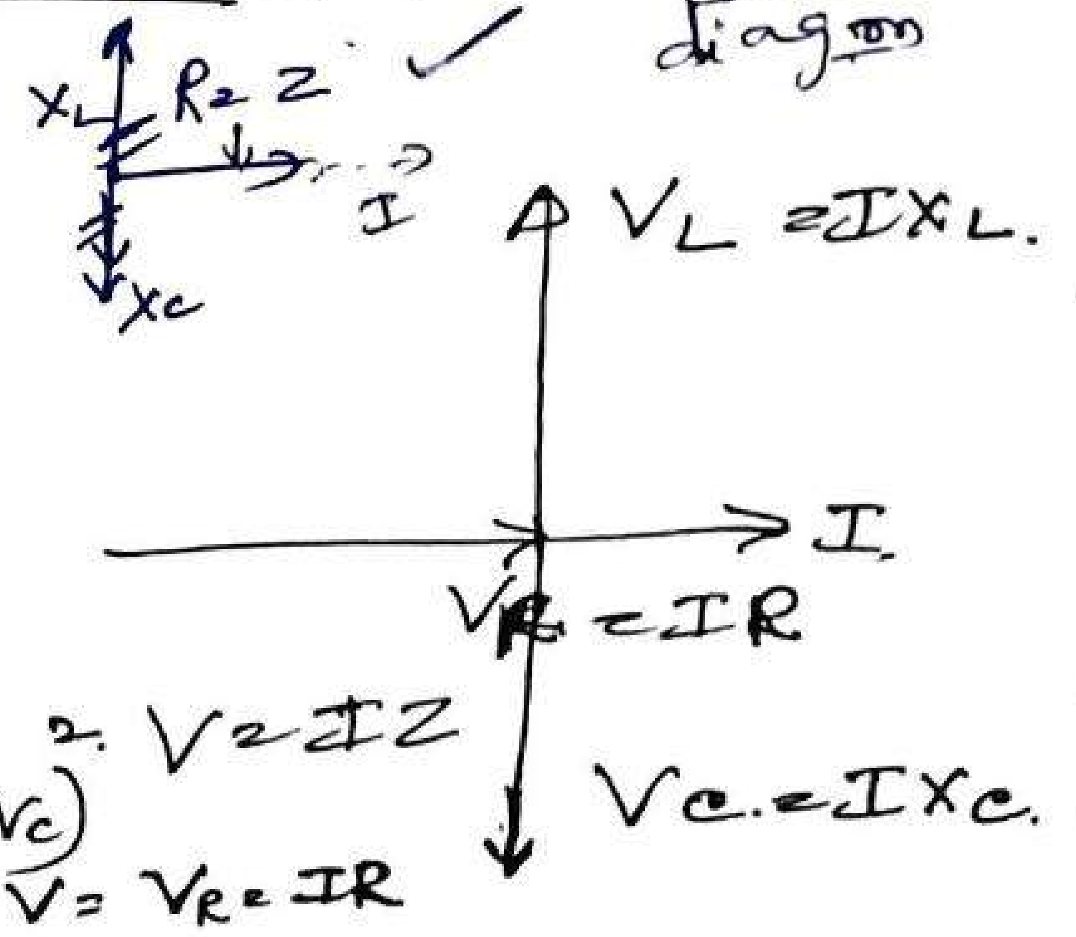
$$V^2 = I^2\left(R^2 + (X_C - X_L)^2\right)$$

$$I = \frac{V}{\sqrt{R^2 + (X_C - X_L)^2}} = \frac{V}{Z}.$$

where, $Z_1 = \sqrt{R^2 + (X_C - X_L)^2}$

Then curret equn is, $i = I_m \sin(\omega t + \phi)$

and power consumed $\underline{P = VI \cos\phi.}$



Impedance diagram

Case 3: $X_L = X_C$

When the inductive reactance is equal to capacitive reactance,

$IX_L = IX_C$

$V_L = V_C.$

$V^2 = V_R^2 + (V_L \sim V_C)^2.$ $V = IZ$

$V^2 = V_R^2 = \therefore V = V_R = IR$

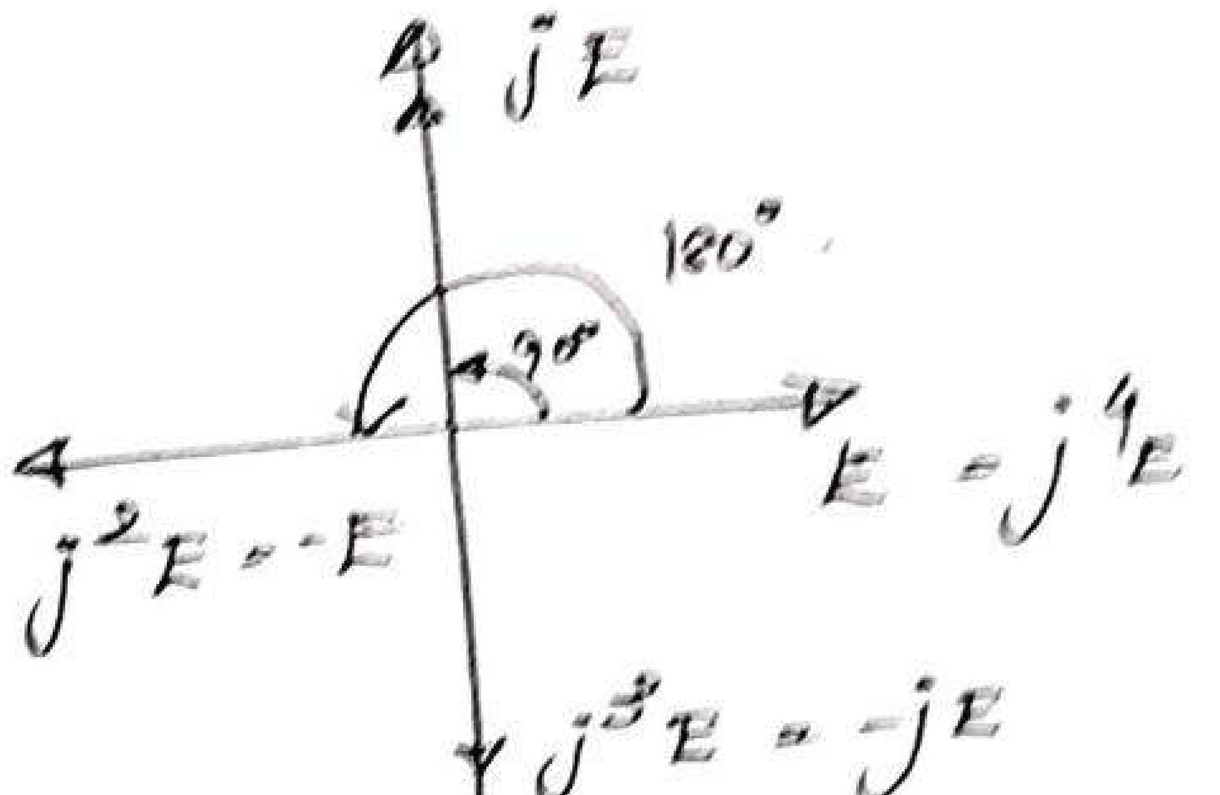
The vector diagram is as shown. V_L and V_C cancel each other. Hence the cur is inphase with the voltage and the ckt. behar as a pure resistance ckt. Hence $Z = R.$ and equation for curret is, $i = I_m \sin\omega t.$

Power consumed $\underline{P = VI}$ $\cancel{\phi}$ $\cos\phi = \frac{R}{R} = 1$

j operator

'j' is an operator which is used to indicate the anticlockwise rotation of a vector through 90°. Its value is $\sqrt{-1}$. When a vector is multiplied by j, it gets itself rotated through 90° in ACW ~~rot~~ direction.

In fig shown, $\vec{E}$ is a vector along x-axis. When it is multiplied by ~~a~~j, it gets itself rotated by 90° and becomes jE.



$j = 90°$ rotation in ACW direction ⇒ jE.

$j^2 = 180°$ rotation in ACW direction ⇒ $j^2E = -E$

$j^3 = 270°$ rotation in ACW dirn. ⇒ $j^3E = -jE$.

$j^4 = 360°$ rotation in ACW dirn. ⇒ $j^4E = -1 \times -1E = E$.

Different forms of representation of a vector

(1) Rectangular form $\vec{Z} = R + jX$

(2) Polar form $\vec{Z} = |Z| \angle \phi$

where $|Z| = \sqrt{R^2+X^2}$ & $\phi = \tan^{-1}(X/R)$

3. Exponential form $\vec{z} = ze^{j\phi}$.

4. Trigonometric form $\vec{z} = z\cos\phi + j\,z\sin\phi$.

Addition or Subtraction of two vectors.

For addition or subtraction, the vectors should be in rectangular form.

Let $\vec{E_1} = a_1 + jb_1$ $\quad E_2 = a_2 + jb_2$.

$$\vec{E_1} + \vec{E_2} = (a_1+a_2) + j(b_1+b_2).$$

$$= \sqrt{(a_1+a_2)^2 + (b_1+b_2)^2} \angle \tan^{-1}\left(\frac{b_1+b_2}{a_1+a_2}\right)$$

$$\vec{E_1} - \vec{E_2} = (a_1-a_2) + j(b_1-b_2)$$

$$= \sqrt{(a_1-a_2)^2 + (b_1-b_2)^2} \angle \tan^{-1}\left(\frac{b_1-b_2}{a_1-a_2}\right)$$

Multiplication and division of two vectors

For multipln. & divisn., the two vectors should be in polar form.

Let $\vec{E_1} = E_1 \angle \phi_1$ & $\vec{E_2} = E_2 \angle \phi_2$.

Then, $$\frac{\vec{E_1}}{\vec{E_2}} = \frac{|E_1|}{|E_2|} \angle \phi_1 - \phi_2. = E \angle \phi.$$

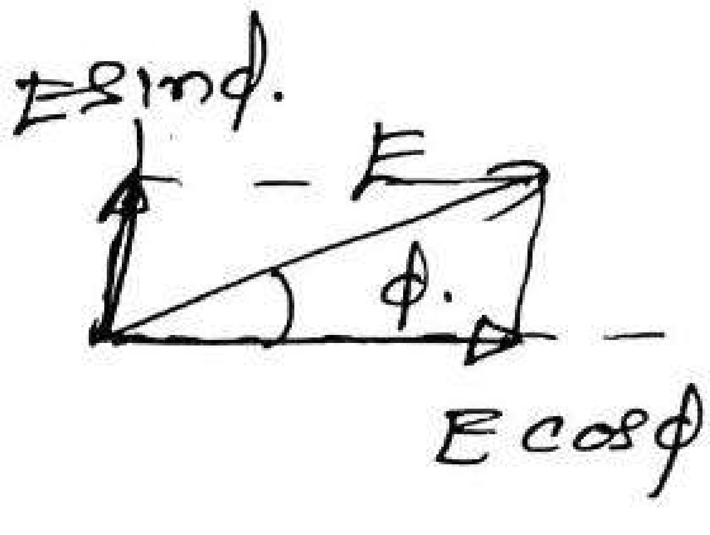
$$\vec{E_1} \cdot \vec{E_2} = |E_1|\,|E_2| \angle \phi_1 + \phi_2.$$

$$= E \angle \phi.$$

Conversion of vectors from polar to rectangular form

Let the vector in polar form be $\vec{E} = E\angle\phi$

$\vec{E} = E\angle\phi$ ← polar form.



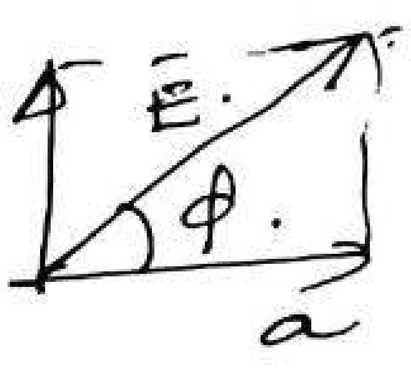
$= E\cos\phi + j\,E\sin\phi$

$\vec{E} = a+jb$ ↑ Rectangular form

Conversion from rectangular to polar form

$\vec{E} = a+jb$ ← rect^{lr}. form.

$= \sqrt{(a^2+b^2)}\;\angle\tan^{-1}\frac{b}{a})$



$\vec{E} = E\angle\phi$ ← polar form.

Power Triangle and its components.

1. Apparent power (S) — The product of r.m.s values of voltage and current is called the apparent power and is measured in volt amperes (VA) or in kilo-volt amperes (KVA).

$S = VI.$

unit → VA or KVA.

2. **Real Power (p)**- This is the actual power consumed in an ac ckt which is obtained by multiplying the apparent power by the power factor and is expressed in watts or kilowatts. (kw) This is also known as active power. or average power

(wattful power)

$$\text{Real power} = VI\cos\phi$$

P.

$$= \text{volt amps.} \times \text{p.f.}$$

units → watts or kwatts.

$P = VI\cos\phi$. But $\cos\phi = \frac{R}{Z}$ f.

$V = IZ$.

$$P = (IZ)(I)\left(\frac{R}{Z}\right)$$

$$P. = I^2R \text{ watts.}$$

Hence, the active power is the power consumed in a resistor.

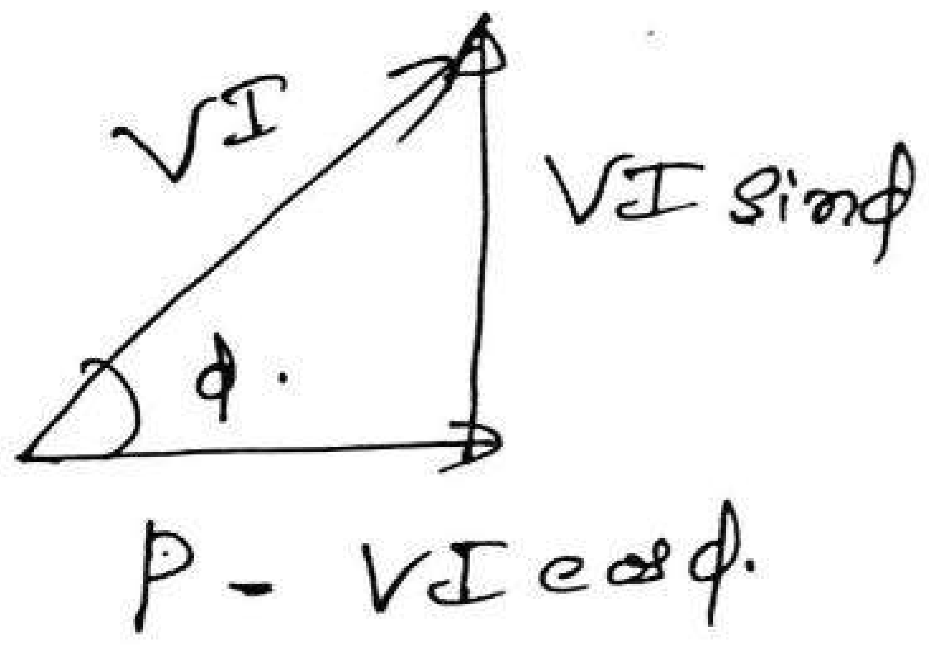
3. **Reactive power(Q)**- It is the power developed in the reactance of the ckt. It is given by,

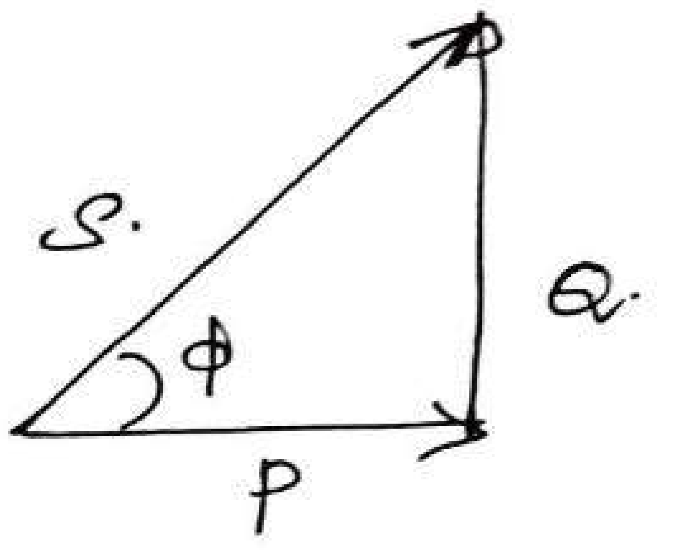
$Q = VI\sin\phi$. and is measured in VAR.

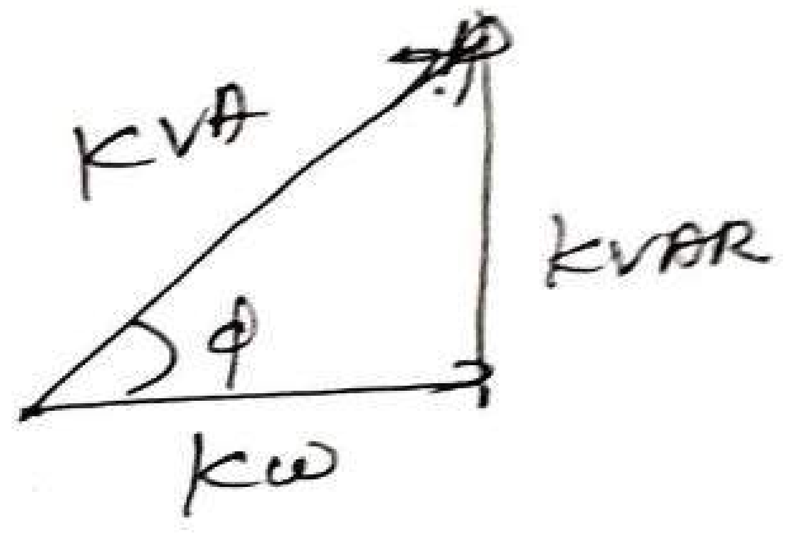
units → Reactive volt amperes.

→ VAR.

The power Δle is as shown.







$S = P + jQ.$

From power Δle,

$$S^2 = P^2 + Q^2 \Rightarrow (\cancel{kVA})^2 = k\omega)^2 + (kVAR)^2.$$

$$(kVA)^2 = (k\omega)^2 + (k.VAR)^2.$$

$$p.f = \cos\phi = \frac{k\omega}{kVA} = \frac{P}{S}.$$

$$\cos\phi = \frac{kVI\cos\phi}{kVI.}$$

Power factor and its significance

Power factor can be defined as,

(1) cosine of the angle between voltage & current

(2) $\underset{\cos\phi}{p.f} = \frac{R}{Z} = \frac{\text{resistance}}{\text{Impedance}} = \frac{R}{\sqrt{R^2+X^2}}$

(3) $\cos\phi = \frac{\text{watts}}{\text{volt-amperes}} = \frac{\text{Real power}}{\text{Apparent power}}$

$$\cos\phi = \frac{VI\cos\phi}{VI.} = \frac{kW}{kVA} = \frac{KW}{KVA.}$$

Significance

The actual power or active power consumed by the load is $P = VI\cos\phi$.

① If the p.f of the load decreases, the active power generated by an alternator and the active power transmitted and recieved by the consumer decreases.

② To generate the same active power from the generator at low p.f, as at good (high) p.f, the capacity of the gentr. has to be increased. This involves additional investment on generation

③ For transmitting a certain power, P, if p.f reduces, then current should be increased to keep the power constant. If current I ↑ses, then, I^2R loss will increase; and efficiency of transmission decreases. ie $P = VI\cos\phi \downarrow$

④ Also, for large current, c/s of the condrs. should be increased, large size of the conductors means increase in volume and weight and hence the cost.

Therefore, the p.f should be as high as possible. But most of the loads are inductive in nature, and hence the p.f will be low. To improve the p.f, static condensers (capacitors) are connected in parallel.

⑤ If the curret. I lags V, p.f is lagging.
(inductive load)

If the curret I leads V, p.f is leading.
(capacitive load).

If the curret. I is in phase with V, p.f is unity.
(Resistive load)

∴ For heaters & incandescent lamps → p.f = 1. upf unity pf loads.

For motors, tube lights, etc. p.f → lagging.

For capacitors, condensers etc p.f → leading.

The magnitude of p.f varies from 0 to 1.

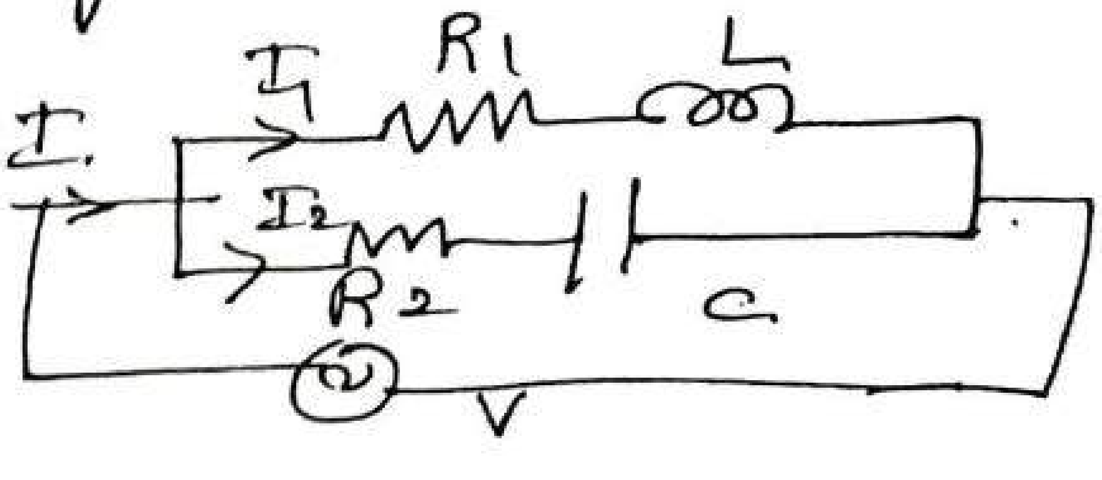
Parallel AC ckts

Consider a parallel ckt. with impedances Z_1 and Z_2 connected in parallel across the voltage source of rms value V volts as shown in fig. In a parallel AC ckt., the voltage across each branch is the same, but the current in each branch differs according to the value of impedance in that branch. Since alternating currents are vector quantities the total current is the vector sum of branch currents. These parallel AC ckts. can be solved by 3 methods:-

(1) Vector method.
(2) Symbolic (j) method.
(3) Admittance method.

(1) Vector method.

In this method, the total line current is obtained by drawing the vector diagm. of the ckt. The voltage vector is drawn as the reference vector since voltage is common, and various branch currents are represented vectorially. The total curret is determined by the method of components. Consider the followg. ckt.



Impedance $Z_1 = \sqrt{R_1^2 + X_L^2} \angle \tan^{-1} \frac{X_L}{R}$

$\vec{Z_1} = Z_1 \angle \phi_1$ $\quad I_1 = \frac{V}{Z_1}$ $\quad \phi_1 = \tan^{-1} \frac{X_L}{R}$

$\therefore$ Current $I_1 = \frac{V}{Z_1 \angle \phi_1} = |I_1| \angle -\phi_1$

Current I_1 lags behind the voltage by $\angle \phi_1$.

Impedance $Z_2 = \sqrt{R_2^2 + X_C^2} \angle -\tan^{-1} \frac{X_C}{R}$

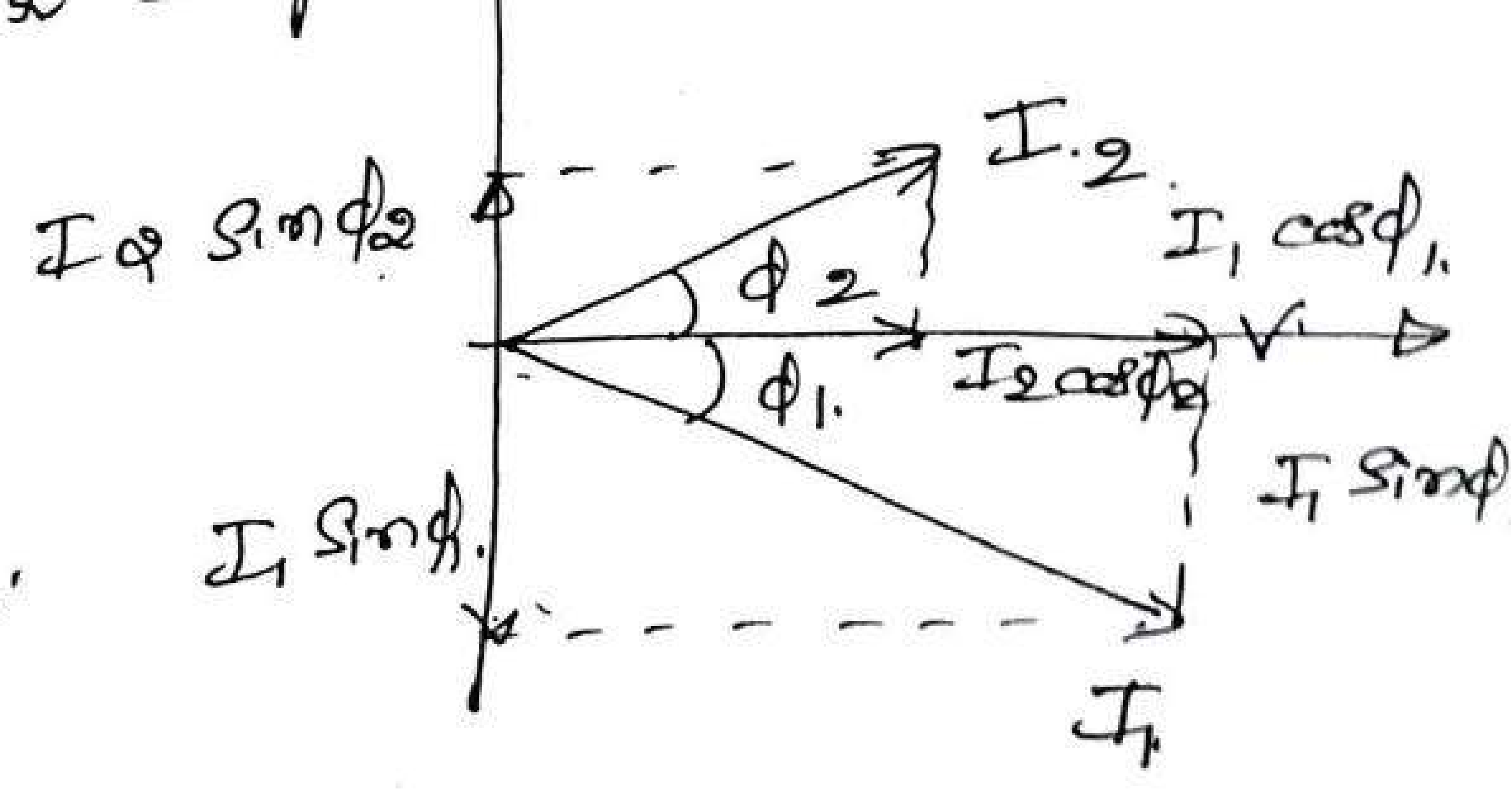
$= |Z_2| \angle -\phi_2$ $\quad I_2 = \frac{V}{Z_2}$ $\quad \phi_2 = \tan^{-1} \frac{X}{R}$

$\therefore$ Current $I_2 = \frac{V}{Z_2 \angle -\phi_2} = \frac{V}{Z_2} \angle +\phi_2 = I_2 \angle \phi_2$

$\therefore$ current I_2 leads V by ϕ_2.

The vectors are drawn as shown. (I_1 & I_2)

Resolving them into their components, we get,



$\Sigma X = I_1 \cos \phi_1 + I_2 \cos \phi_2$

$\Sigma Y = -I_1 \sin \phi_1 + I_2 \sin \phi_2$

$I = \sqrt{(\Sigma X)^2 + (\Sigma Y)^2}$

$\phi = \tan^{-1} \frac{\Sigma Y}{\Sigma X}$ $\qquad \therefore \vec{I} = I \angle \phi$

② Symbolic or j. method

$Z_1 = R_1 + jX_L = Z_1 \angle \phi_1.$

$Z_2 = R_2 - jX_C = Z_2 \angle -\phi_2.$

we have, $\vec{I} = \vec{I_1} + \vec{I_2}$

$I_1 = \frac{V}{Z_1 \angle \phi_1} = \left|\frac{V}{Z_1}\right| \angle -\phi_1.$

$\vec{I_1} = |I_1| \angle -\phi_1$

$I_2 = \frac{V}{Z_2 \angle -\phi_2} = \left|\frac{V}{Z_2}\right| \angle \phi_2.$

$\vec{I_2} = I_2 \angle \phi_2$

$\vec{I} = \vec{I_1} + \vec{I_2} = I_1 \angle -\phi_1 + I_2 \angle \phi_2.$

$= (I_1 \cos\phi_1 + I_2 \cos\phi_2) + j\; I_2 \sin\phi_2 - I_1 \sin\phi_1.$

$I = I_x + j\,I_y. = \sqrt{I_x^2 + I_y^2} \angle \tan^{-1}\frac{I_y}{I_x}$

$\vec{I} = |I| \angle \phi.$

Admittance [illegible].

The reciprocal of impedance of a ckt. is called its admittance. It is represented by Y.

Admittance $= \vec{Y} = \frac{1}{Z} = \frac{I}{V}.$

Scanned by TapScanner

Its unit is ($\mho$ (mho) or) Siemens (S).

Admittance of R-L series ckt.

$$Z = R + jX_L.$$

$$Y = \frac{1}{Z} = \frac{1}{R + jX_L}$$

× by complex conjugate,

$$Y = \frac{R - jX_L}{(R + jX_L)(R - jX_L)}$$

$$Y = \frac{R}{R^2 + X_L^2} - j\frac{X_L}{R^2 + X_L^2}$$

$$Y. = G - jB = \frac{R}{Z^2} - j\frac{X_L}{Z^2}.$$

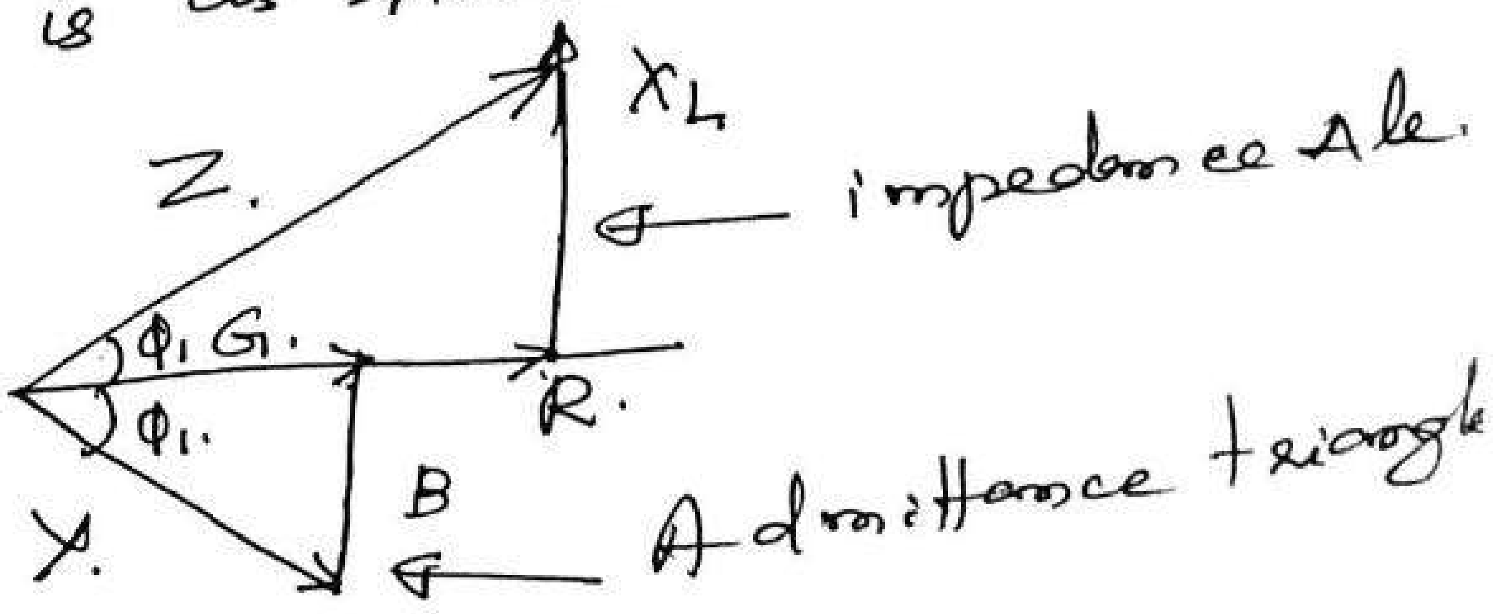
where G = conductance of the ckt in $\mho$ (mho).

$$G. = \frac{R}{Z^2}.$$

B = susceptance of the ckt in $\mho$.

$$B = \frac{X_L}{Z^2}.$$

Admittance Δle is as shown below.



Admittance for R-c ckt

$$Z = R - j X_c.$$

$$Y = \frac{1}{R \mp j X_c}$$

$$Y = \frac{R + j X_c}{(R - j X_c)(R + j X_c)}$$

$$Y = \frac{R}{R^2 + X_c^2} + j \frac{X_c}{R^2 + X_c^2}$$

$$Y = G + j B.$$

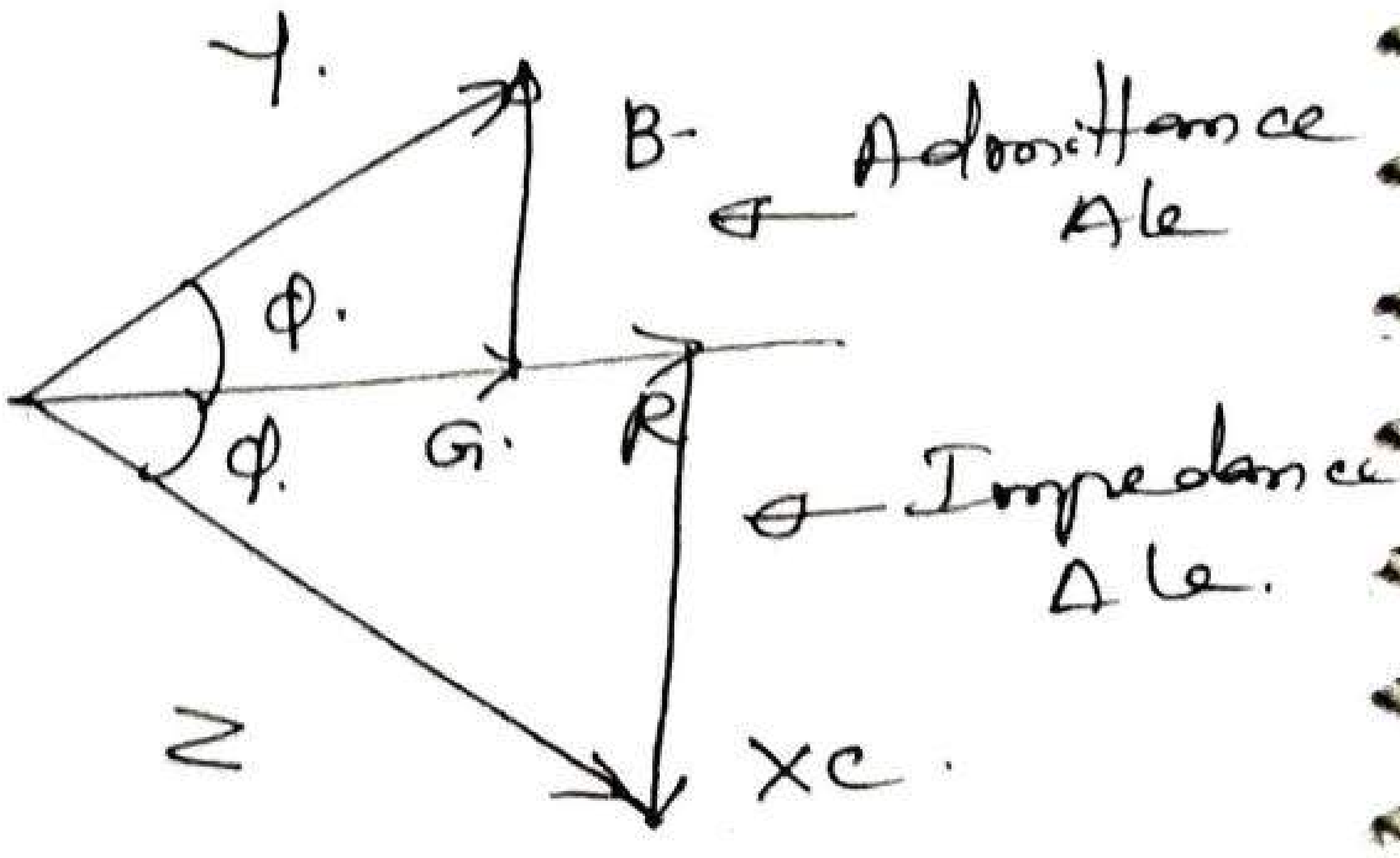
where $G = \frac{R}{R^2 + X_c^2} = \frac{R}{Z^2}$ is the conductance in ℧.

$B = \frac{X_c}{R^2 + X_c^2} = \frac{X_c}{Z^2}$ is the susceptance in ℧.

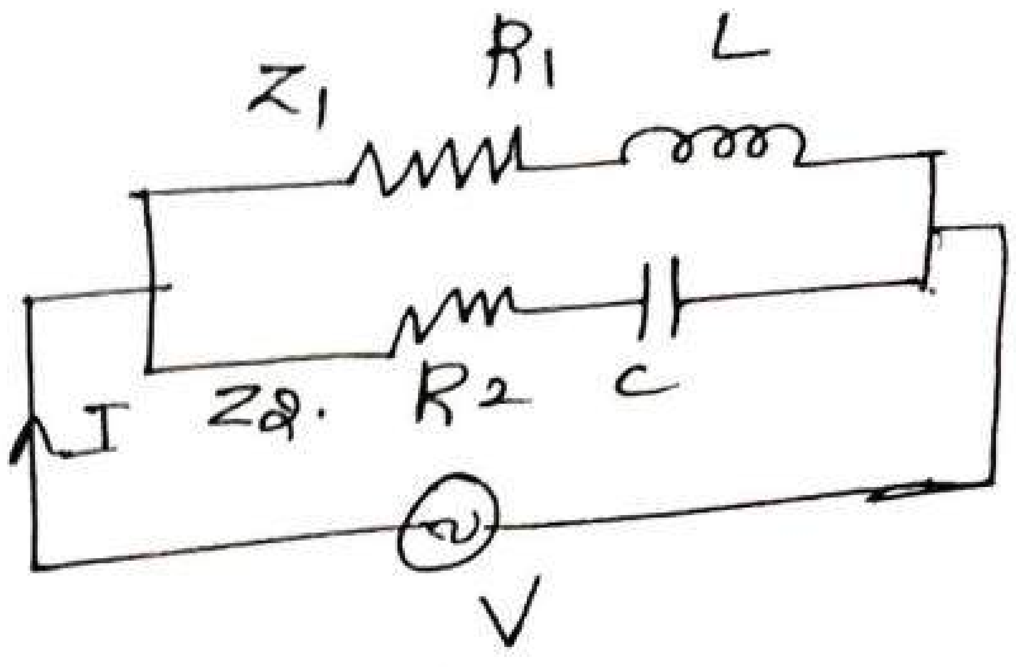
$Y = G \pm j B.$ in general.

Hence,

Admittance Triangle



3. Admittance method



Consider the same ckt. as shown. The susceptances and conductances for 2 branches are calculated separately.

$Z_1 = R_1 + jX_L \quad Z_2 = R_2 - jX_C$

$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2}$

$Y = Y_1 + Y_2$

$Y = G \pm jB$

$G_1 = \frac{R_1}{Z_1^2}$

$B_1 = \frac{-X_L}{Z_1^2}$

$B_2 = \frac{X_C}{Z_2^2}$

$G_2 = \frac{R_2}{Z_2^2}$

The total conductance and susceptance are given by,

$G = G_1 + G_2$

$B = B_1 + B_2 \; (= -B_1 + B_2)$

Then, total admittance $Y = G \pm jB$

$Y = \sqrt{G^2 + B^2} \quad \boxed{\tan^{-1} \frac{\pm B}{G}}$

$= |Y| \angle \pm\phi$

The total current is, $I = VY$

$= VY \angle \pm\phi$

$\vec{I} = I \angle \pm\phi$

$I_1 = \frac{V}{Z_1 \angle \phi_1} = VY_1 \angle -\phi_1 = I_1 = |V| Y_1 \angle -\phi_1$

$I_2 = \frac{V}{Z_2} \angle -\phi_2 = I_2 = |V| Y_2 \angle \phi_2$

$I = VY_1 + VY_2$. $\therefore I = VY_1 + VY_2 + VY_3 + VY_n$

Assignment Questions - Theory (1)

Jul 09

① Explain the following terms : (1) Rms value ② Average value ③ Form factor ④ power factor. (8m)

② Derive an expression for the instantaneous power in a pure capacitor energized by a sinusoidal voltage. Draw the wave shapes of voltage, current & power signals. (8m)

Jan'11

③ In an a.c ckt, define ① Amplitude ② Frequency ③ Formfactor ④ Powerfactor (4m)

June 10.

④. S.T a pure capacitance does not consume any power. Draw the waveforms of voltage, current & power when altg. voltage is applied to the pure capacitance ckt (8m)

Jul 08.

⑤. Derive expressions for avg. value and Rms value of a sinusoidally varying ac voltage and find formfactor (8m)

⑥. S.T avg. power in a pure inductance with sinusoidal voltage is zero. (5m)

⑦ What is powerfactor in ac ckts? Distinguish between lagging and leading p.f. which of the following devices work at upf, lagging p.f and leading p.f?
ⓐ Electric iron ⓑ. Fluorescent lamp. ⓒ incandescent lamp. ⓓ condenser bank to improve p.f. ⓔ induction motor (8m).

⑧ With a neat sketch briefly explain how an alternatg. voltage is produced when a coil is rotated in a magnetic field. (5m).

⑨ Discuss the phasor representation of an altg quantity. (6m

Three phase circuity

Any electrical apparatus having only one winding is called a single phase system. If there are two windings. such that the currents flowing through them have a phase difference of 90°, then they are called two phase systems.

[If there are three windings in them connected such that the currents flowing through them have a phase difference of 120° between them, then they are called three phase systems.]

If there are more than 3 windgs. in them, then they are called polyphase systems. Then, the phase difference betn. their currents = $\phi = \frac{360°}{m}$. where m = no. of phases.

Advantages of 3 phase systems

① A 3 phase machine is more efficient than a single phase machine.

② The size of a 3ϕ machine is smaller than that of 1ϕ machine of the same capacity. Therefore it requires less material for its construction.

③ The cost of a 3ϕ machine is lesser than a 1ϕ machine of the same rating.

④ The transmission and distribution of the power along the same distance requires less copper than in case of a 3ϕ line compared to the 1ϕ line. Also the transmission losses are lesser in case of a 3ϕ line, and hence economical

⑤. Three phase motors are self - starting, whereas 1ϕ motors are not self starting.

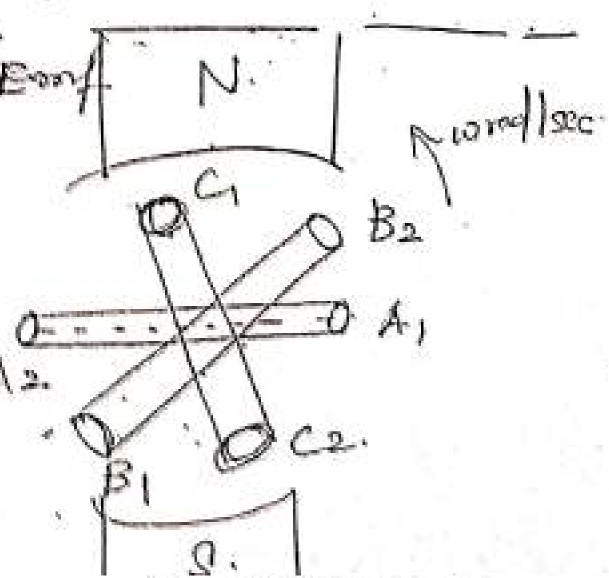
⑥ 3ϕ motors produce uniform torque whereas, the torque produced by 1ϕ motors is pulsating.

⑦. The connection of single phase generators in parallel give rise to harmonics, whereas three phase gentrs can be ~~conn~~ connected in parallel without giving rise of to harmonics.

⑧ In case of a 3ϕ - star system, 2 different voltages can be obtained - one between the lines and other between a line and (phase) neutral.

Generation of 3- phase emf

In a 3ϕ system, there are 3 equal voltages displaced from one another by 120° in phase.



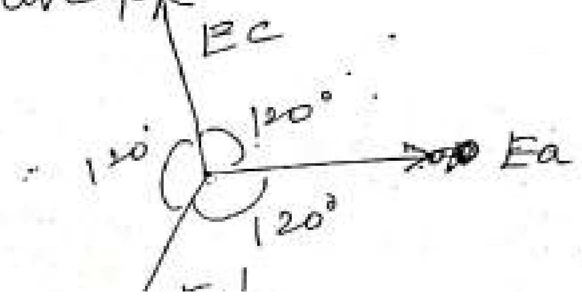
These voltages are produced by a 3ϕ generator (called an alternator) which has 3 identical windgs which are displaced by 120° in phase when these 3 windgs are rotated in a magnetic field, emf is induced in each windgs.

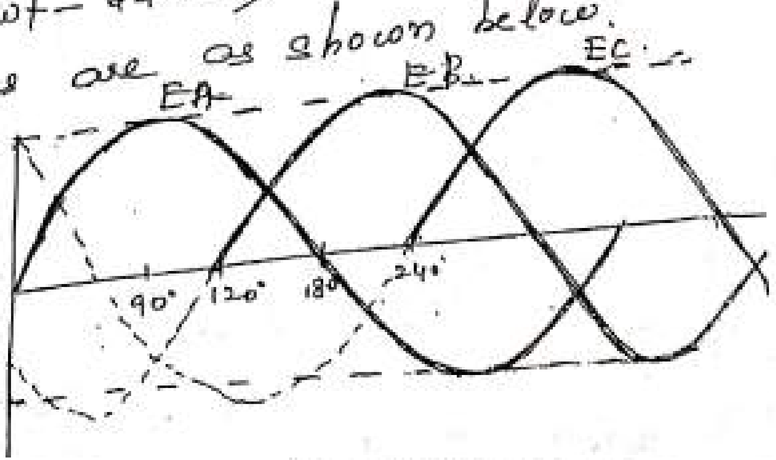
Consider 3 coils A (A1 A2), B (B1 B2) and C (C1 C2) mounted on the same axis but displaced from eachother by 120°. Let the three coils be rotated in ACW direction in a magnetic field of North and South poles as shown in fig. when the coils rotated the flux is cut by the coils and hence a sinusoidal emf is produced in each coil. As the no of conductors in each windg is the same, the maximum values of the emfs induced are equal but they are displaced by 120° from one another. The 3 emfs induced in 3 coils are given as follows.

$e_A = E_m \sin \omega t$ in coil A

$e_B = E_m \sin(\omega t - 120°)$ in coil B

$e_C = E_m \sin(\omega t - 240°)$ in coil C. The wave forms and vectors are as shown below.





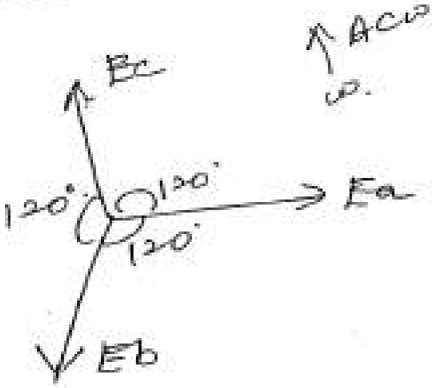
The comm
similar end
is called t

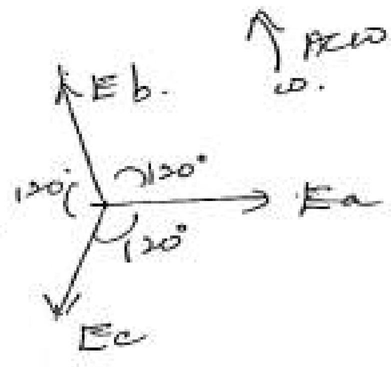
phase sequence

The order in which the voltages in the 3 phase wi-dings reach their maximum +ve values is called the phase sequence. If the phase sequence is A-B-C, the emf in coil A leads the emf in coil B and C by 120° and 240° resply i.e EA reaches maximum first, then Eb and EC. when coils A, B & C are rotating in new direction

phase sequence A-BC

phase sequence A-C-B





$E_a = E\angle 0\ V$

$E_b = E\angle -120°\ V.$

$E_c = E\angle -240°\ V.$

$E_a = E\angle 0\ V$

$E_c = E\angle -120°\ V$

$E_b = E\angle -240°\ V$

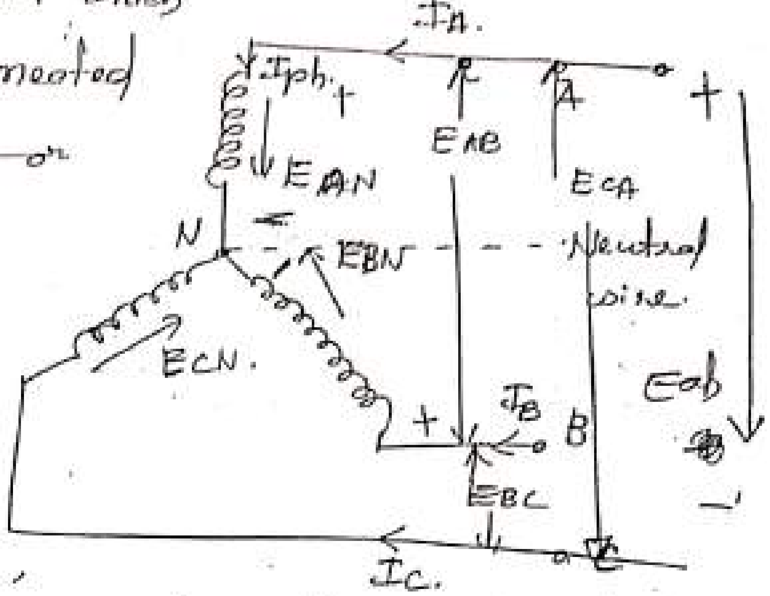
Three-phase connections

There are 2 types of 3 phase connections.

(i) star connection (ii) Delta connection

(i) star connection is obtained by joining the 3 similar ends (either start or finish) together and other 3 ends are joined to the line wires as shown in fig

The common point N at which similar ends are connected is called the star point or neutral point. When the neutral wire is also taken out for an external connection, with 3 line wires, it is called a 4 wire, 3φ system. If only 3 lines are taken for external connection, it is called a 3 wire - 3φ ~~st~~ system.



The voltage between any line and neutral point is called the phase voltage, because it is the voltage across the phase winding. They are equal in magnitude. The voltage between any two lines is called the line voltage. They are also equal to one another in magnitude.

In fig shown, EAN, EBN, & ECN are phase voltag. EAB, EBC, ECA are the line voltages.

i.e. $E_{AN} = E_{ph} \angle 0 \; V$

$E_{BN} = E_{ph} \angle -120^\circ \; V$

$E_{CN} = E_{ph} \angle -240^\circ \; V$

are phase voltages.

Line voltages

$E_{AB} = E_L \angle 0 \; V$

$E_{BC} = E_L \angle -120^\circ \; V.$

$E_{CA} = E_L \angle -240^\circ \; V.$

I_A, I_B, I_C are the line currents.

Relation between line and phase quantities

From the above fig, we observe that the currents flowing through the lines are the same as the currents flowing through the phases.

$\therefore$ line current = phase current.

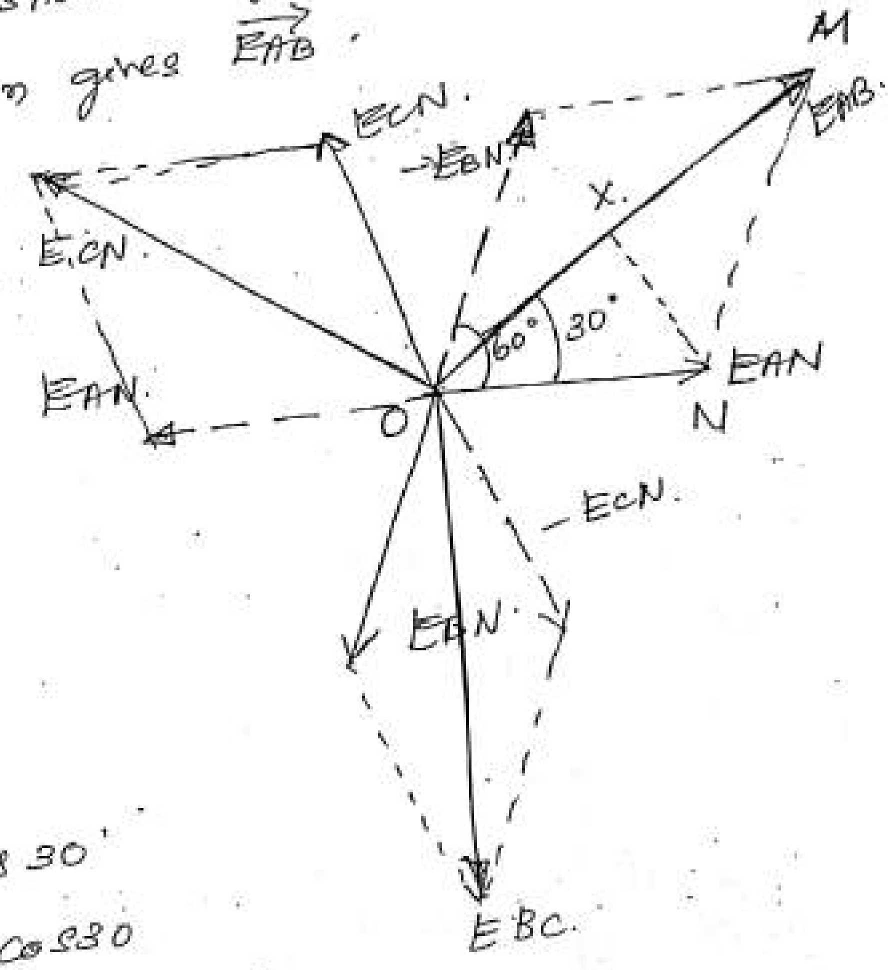
$I_L = I_{ph}$.

From the diagram, we see that,

$E_{AB} = E_{AN} + E_{NB}$

$\vec{E}_{AB} = \vec{E}_{AN} - \vec{E}_{BN}$.

The vector diagram of line voltages and phase voltages are shown in fig 2. The vector sum of E_{AN} and $-E_{bn}$ gives $\vec{E}_{AB}$.



IIIly,

$E_{BC} = E_{BN} - E_{CN}$.

$E_{CA} = E_{CN} - E_{AN}$.

In $\triangle$le OMN,

$OM = 2\,OX$.

$\cos 30 = \frac{OX}{ON}$

$OX = ON \cos 30$

$OX = E_{AN} \cos 30$

$\therefore OM = 2\,E_{AN} \cos 30$.

Scanned with CamScanner

$\therefore OM = 2E_{AN} \cos 30$

$OM = 2E_{AN} \times \frac{\sqrt{3}}{2}$ But $OM = E_{AB}$.

$\therefore E_{AB} = \sqrt{3}\ E_{AN}$.

But $E_{CA} = E_L$

$E_{CN} = E_{ph}$

Illy, $E_{BC} = \sqrt{3}\ E_{BN}$

$E_{CA} = \sqrt{3}\ E_{CN}$.

$\therefore$ In general, $\because$ $E_L = \sqrt{3}\ E_{ph}$

Line voltage = √3 phase voltage

The power consumed by the 3 phase ckt is,

$P = 3 \times$ power in each phase

$= 3 \times E_{ph} I_{ph} \cos\phi$

$= 3 \times \frac{E_L}{\sqrt{3}} I_L \cos\phi$

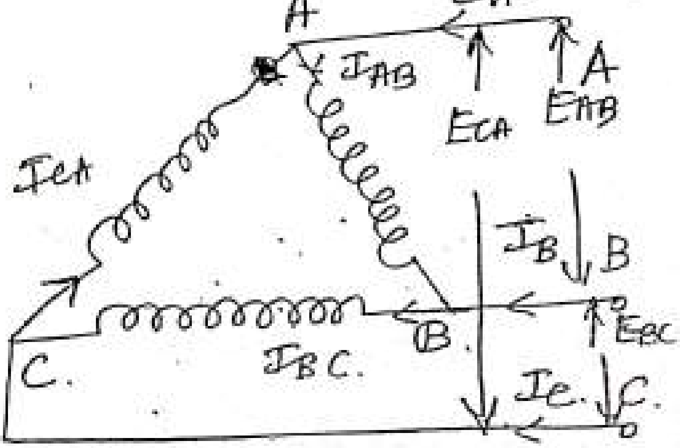
$$P = \sqrt{3}\ E_L I_L \cos\phi$$

where ϕ is the angle between $\vec{E_{ph}}$ and $\vec{I_{ph}}$.

Delta Connection

When the starting end of one coil is connected to the finishing end of another coil, a delta connection is formed as shown in fig.

I_A, I_B and I_C are the line currents and are equal to I_L.



|||ly,

I_{AB}, I_{BC}, and I_{CA} are the phase currents are equal to I_{ph}. From the ckt diagm, it is seen that,

the voltages between the lines are the same as the voltages ~~between~~ across the phases

$$E_L = E_{ph}.$$

∴

The vector diagm of phase currents and line currents is shown below.

Applying KCL at node A, we get

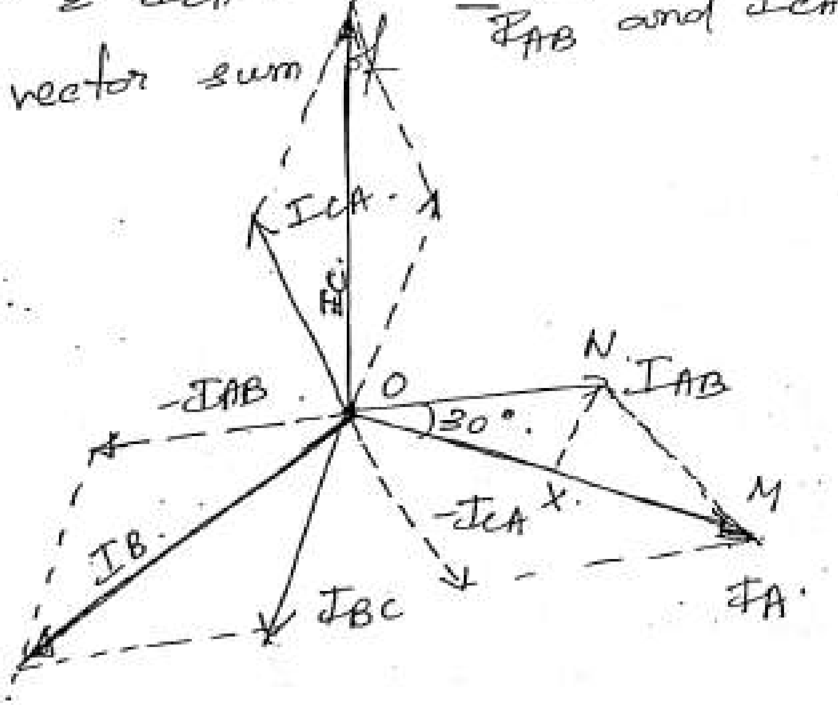
$$\vec{I_A} + \vec{I_{CA}} = \vec{I_{AB}}.$$

$$\therefore \vec{I_A} = \vec{I_{AB}} - \vec{I_{CA}}$$

|||ly, $\vec{I_B} = \vec{I_{BC}} - \vec{I_{AB}}$

$$\vec{I_C} = \vec{I_{CA}} - \vec{I_{BC}}$$

ie $\vec{I_A}$ is the vector sum $\overrightarrow{-I_{AB}}$ and $\overrightarrow{-I_{CA}}$



From Δle OMN,

OM = 2 OX.

$\cos 30 = \frac{OX}{ON}$.

OX = ON cos 30

OX = I_{AB}. cos30

∴ OM = 2 I_{AB} cos 30

$= 2 I_{AB} \frac{\sqrt{3}}{2}$ = $\sqrt{3}\ I_{AB}$

∴ $I_A = \sqrt{3}\ I_{AB}$.

|||ly; $\overrightarrow{I_B} = \sqrt{3}\ \overrightarrow{I_{BC}}$

$\overrightarrow{I_C} = \sqrt{3}\ \overrightarrow{I_{CA}}$

∴ In general, Line current = √3 phase curr.

The three phase power } i.e. $I_L = \sqrt{3}\ I_{ph}$

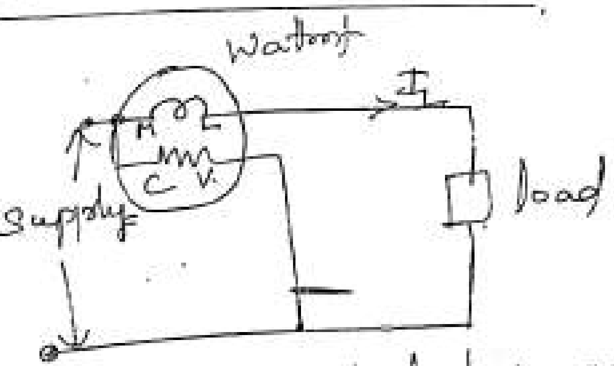
$p = 3\ E_{ph}\ I_{ph} \cos\phi$

$= 3 \times E_L \frac{I_L}{\sqrt{3}} \cos\phi$

$P_{3\phi} = \sqrt{3}\ E_L I_L \cos\phi$

Measurement of power in a 3φ ckt

The power in an electrical ckt is measured by using a wattmeter.



A wattmt consists of

(1) a current coil ML which is connected in series with the ckt and the line current flows through it.

② a potential coil which is connected in parallel with the ckt, as shown in fig. The full voltage i.e is applied across the potential coil.

Balanced supply and load

A 3 phase supply is balanced when all the three voltages have the same magnitude but differ in

~~magnitude~~ phase by exactly 180° w.r.t one another.

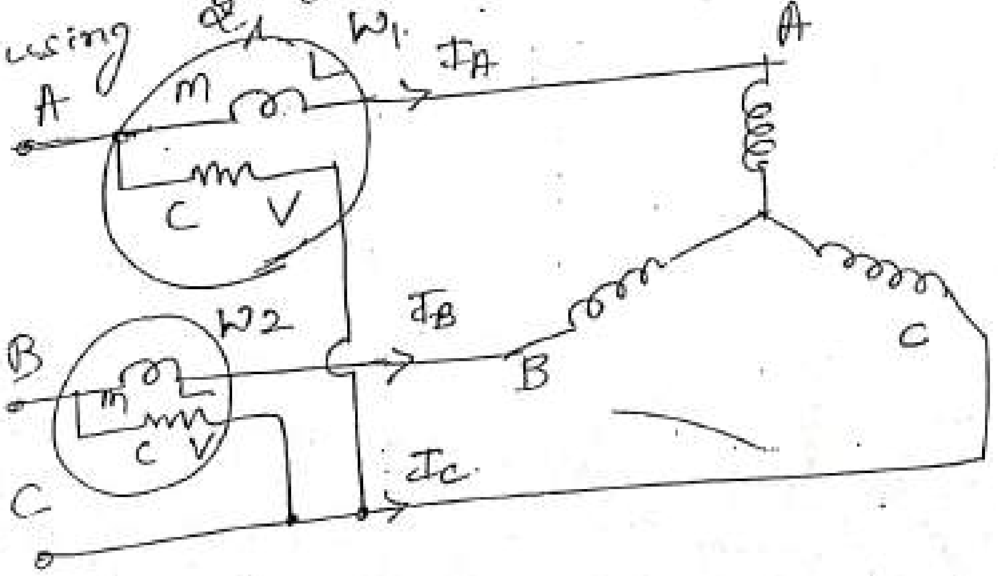
- Balanced load is the load in which the impedances of all the three phases are exactly the same. Then, the currents through the 3 phases will be of equal magnitude and out of phase by 180° (exactly).

Measurement of power in a 3φ balanced load using two wattmeters

When the impedances of the 3phases are equal, the load is said to be balanced. The supply is balanced if the 3 voltages are equal and are displaced by 180° w.r.t one another.

When a balanced supply is connected to a balanced load, the currents flowing through the 3 phases are equal in magnitude and are displaced by 180° w.r.t one another.

We can measure the power consumed in a 3φ load by using 2 1φ wattmeters & connected as shown.



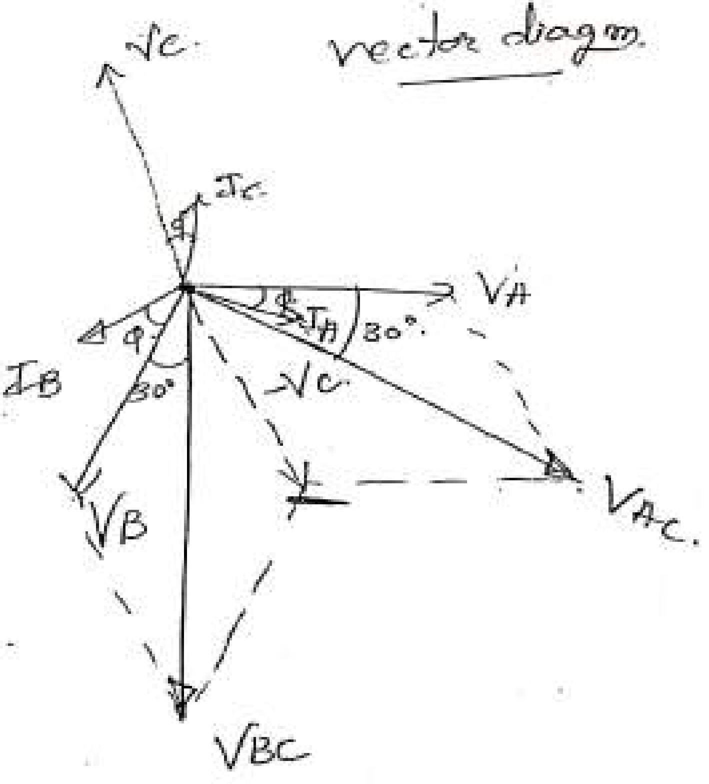
The wattmt reading W_1 is given by,

W_1 = voltage across its potential coil
× current through its current coil
× cosine of angle between the voltage and current.

$\therefore W_1 = V_{AC} \; I_A \cos(\angle le \text{ betn. } V_{AC} \;\&\; I_A)$

$W_2 = V_{BC} \; I_B \cos(\angle le \text{ betn. } V_{BC} \text{ and } I_B)$

Consider a lagging p.f load, due to which the phase currents I_A, I_B & I_C will lag the phase voltages V_A, V_B & V_C by angle of ϕ as shown in the vector diagm



The angles are found by using the vector diagm.

In the diagm, $\overrightarrow{V_{AC}} = \overrightarrow{V_A} - \overrightarrow{V_C}$.

$\overrightarrow{V_{BC}} = \overrightarrow{V_B} - \overrightarrow{V_C}$.

Angle betn. V_{AC} & I_A = $(30 - \phi)$

nd angle betn. V_{BC} and I_B is $(30 + \phi)$

$\therefore W_1 = V_{AC} I_A \cos(30-\phi).$

$= V_L I_L \cos(30-\phi).$

$W_2 = V_{BC} I_B \cos(30+\phi)$

$W_2 = V_L I_L \cos(30+\phi)$

$\therefore W_1 + W_2 = V_L I_L \cos(30-\phi) + V_L I_L \cos(30+\phi)$

$= V_L I_L (2 \cos 30 \cos\phi).$

$= V_L I_L \; 2 \times \cos\phi \times \frac{\sqrt{3}}{2}$

$\underline{W_1 + W_2 = \sqrt{3} \; V_L I_L \cos\phi}$

The sum of two wattmt readings gives the total power consumed in the ckt. Hence, 2 watt-mts are sufficient to measure power in a 3φ ckt

To find the angle and p.f

$W_1 - W_2 = V_L I_L (\cos(30-\phi) - \cos(30+\phi))$

$= V_L I_L (2 \sin 30 \sin\phi)$

$W_1 - W_2 = V_L I_L \sin\phi.$

Effect of p.f on W_1 & W_2 → Refer class notes:

$\therefore \frac{W_1 - W_2}{W_1 + W_2} = \frac{\sqrt{3}\cancel{V_L I_L \cos\phi}}{\cancel{V_L}} \qquad \frac{V_L I_L \sin\phi}{\sqrt{3} V_L I_L \cos\phi}$

$\frac{W_1 - W_2}{W_1 + W_2} = \frac{1}{\sqrt{3}} \tan\phi. \quad \therefore \tan\phi = \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)$

$\therefore \cos\phi = \cos\left(\tan^{-1} \frac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}\right)$

Effect of power factor on wattmeter readings

The wattmeter readings are given by

$W_1 = V_L I_L \cos(30-\phi)$ &

$W_2 = V_L I_L \cos(30+\phi)$.

(i) Case 1 when $\cos\phi = 1$. (p.f) , $\phi = 0°$.

$W_1 = V_L I_L \cos(30-0)$. $= V_L I_L \cos 30$.

$W_2 = V_L I_L \cos(30+0) = V_L I_L \cos 30$.

$W_1 = \frac{\sqrt{3}}{2} V_L I_L$ and $W_2 = \frac{\sqrt{3}}{2} V_L I_L$

∴ $\boxed{W_1 = W_2}$ both equal.

(ii) case 2. when $\cos\phi = 0$, $\phi = 90°$.

$W_1 = V_L I_L \cos(30-90°) = \frac{V_L I_L}{2}$

$W_2 = V_L I_L \cos(30+90°) = -\frac{V_L I_L}{2}$

$\boxed{W_2 = -W_1}$ one of them is -ve.

③ Case 3. when $\cos\phi = 0.5$ then $\phi = 60°$.

$W_1 = V_L I_L \cos(30-60°) = \frac{\sqrt{3}}{2} V_L I_L$.

$W_2 = V_L I_L \cos(30+60°) = 0$

One of the wattmeters reads zero.

④ Case 4 when $\cos\phi = \frac{\sqrt{3}}{2} = 0.866$, $\phi = 30°$

$W_1 = V_L I_L \cos(30-30°) = V_L I_L$

$W_2 = V_L I_L \cos(30+30) = \frac{V_L I_L}{2}$

$\boxed{W_1 \& W_2}$ both are +ve.

Single phase Transformers

* A transformer is a static electrical device by means of which electrical power in one circuit is transformed into an electrical power of the same frequency in another ckt., without change of power.

* It can raise or lower the voltage in a ckt. but with corresponding decrease or increase in current with the power transferred being constant.

* The physical basis of the transformer is mutual induction between the two ckts. linked by a common magnetic flux.

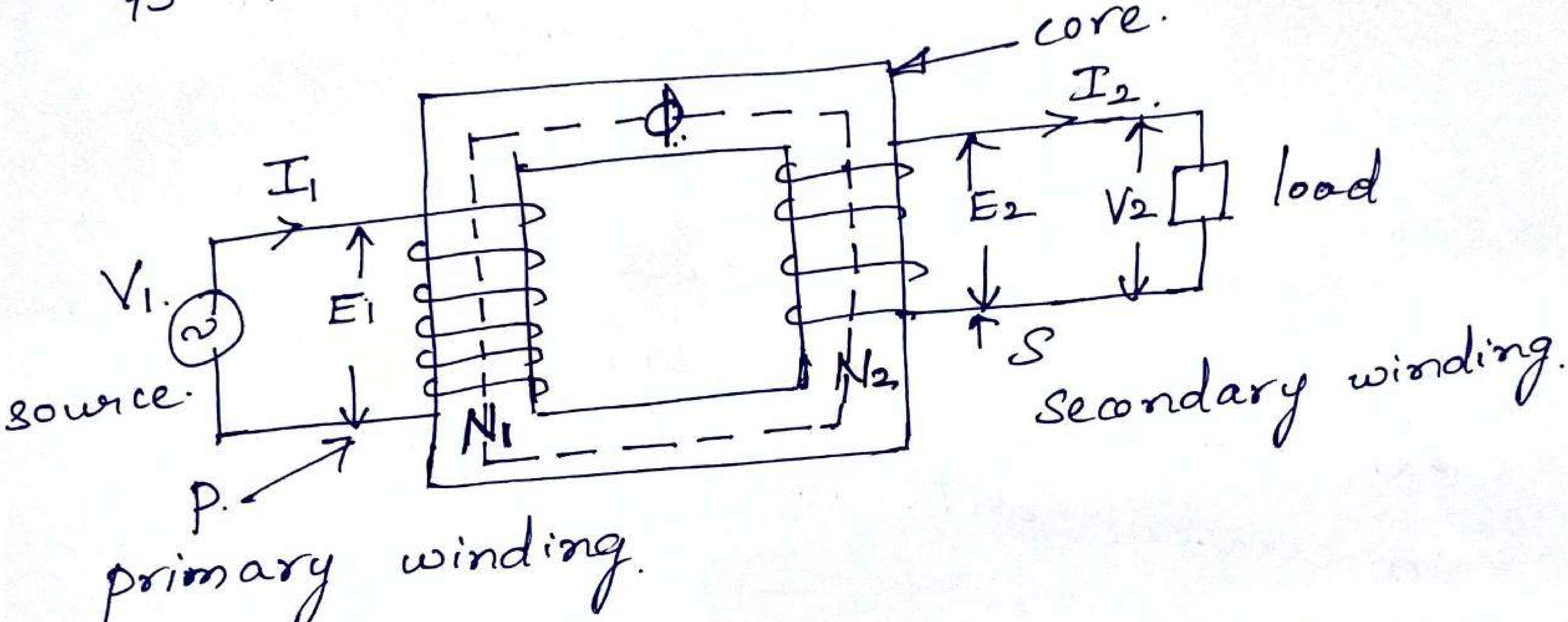
* When the transformer is used for increasing the voltage, it is called a stepup transformer and when it lowers the voltage, it is called a step down transformer.

* It consists of two inductive coils which are electrically separate but magnetically linked by a low reluctance path, which

VD.

may be an iron core as shown in fig. below.

* Since transformer is a static device, there are no moving parts. Therefore no mechanical losses and hence its efficiency is very high. ie 95-98 %. and its maintenance is easy.



* The transformer consists of 2 coils wound on a soft iron core. One of the coils which is connected to the power supply is known as primary winding while the other which is connected to. load is known as secondary winding. These coils are electrically separated from each other (means no contact) but magnetically linked by the flux in the core.

Necessity of a Transformer.

In practice, the 3φ power is generated at 11kV in power stations. The power generated is transmitted, after its voltage level is increased or stepped up by using transformers. The reason for increasing the level of voltages is to lower the currents during transmission. This reduces the I^2R losses in the overhead lines and hence increases the efficiency of transmission. In distribution centres near the cities, the voltage level is once again lowered using transformers, so that it can be used at consumer places, ie at industries and domestic places. All these are possible because of transformers. Hence transformers are necessary for efficient utilization of electrical power generated in power stations.

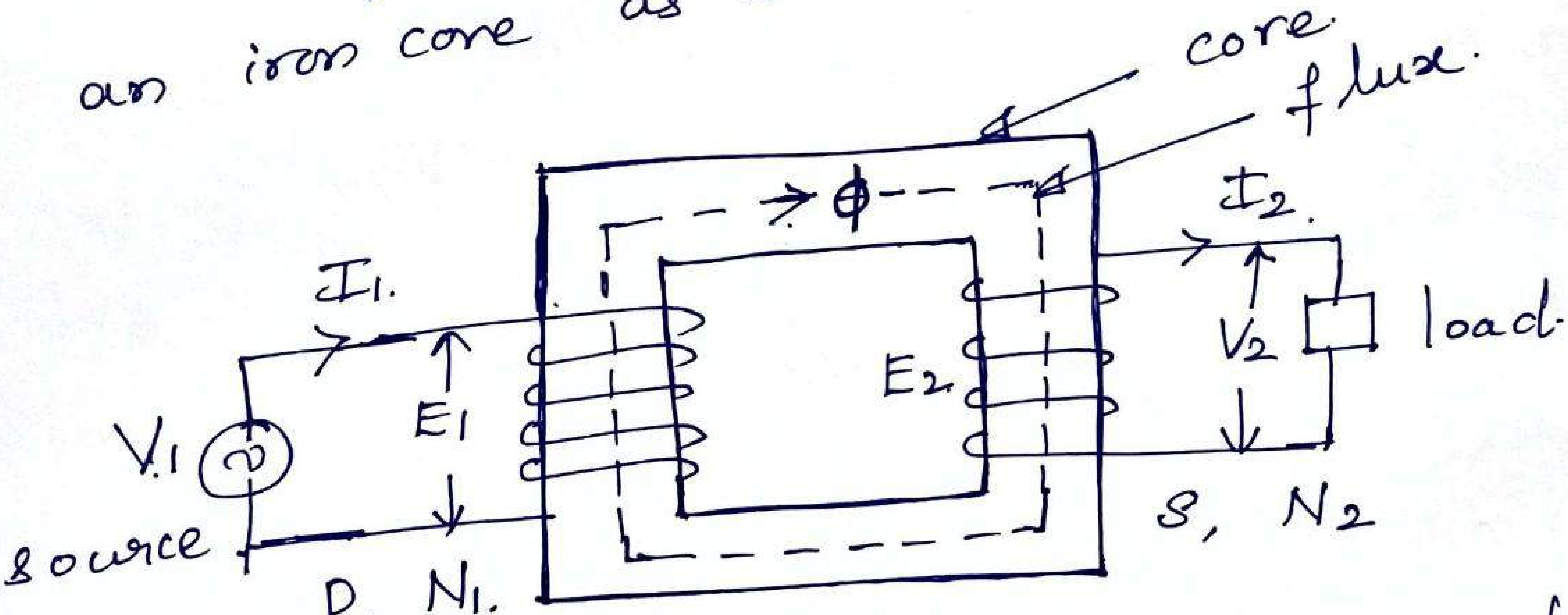
Principle of operation of a transformer.

A transformer is a static device which transforms electrical energy from one ckt.

Principle of operation (continued)

to another without change of power and frequency.

The transformer has two coils, a primary coil which is connected to the source and has N_1 no. of turns and a secondary coil which is connected to the load and has N_2. no. of turns. The 2 coils are mutually linked by a low reluctance path, which is an iron core as shown in fig. below.



When the primary winding is connected to an alternating current I_1 flows through the primary winding and sets up a magne-tic flux ϕ in the core. This flux is alternating in nature and links both primary and secondary windings. This flux produces a self induced emf E_1 in the primary winding and mutually induced

VD

mutually induced emf E_2 in the secondary winding. According to Faraday's laws of E.M.I., the values of E_1 & E_2 are given by,

$E_1 = -N_1 \frac{d\phi}{dt}$ where $N_1 \rightarrow$ no. of turns on primary winding

$E_2 = -N_2 \frac{d\phi}{dt}$ where $N_2 \rightarrow$ no. of turns on secondary winding.

$$\frac{E_2}{E_1} = \frac{-N_2 (d\phi/dt)}{-N_1 \left(\frac{d\phi}{dt}\right)} = \frac{N_2}{N_1} = k.$$

where k is known as transformation ratio.

If $N_2 > N_1$, & $k > 1$. and transformer is called a step up transfr.
Then $E_2 > E_1$.

If $N_2 < N_1$, Then $E_2 < E_1$. } & $k < 1$. - Transformer is called step down transfr.

If $N_2 = N_1$ Then. $E_2 = E_1$ } & $k = 1$. — Then it is an Isolation Transformer.

When a load is connected to the secondary winding, a current I_2 flows through the load, and V_2 is the terminal voltage across the load. As the power transferred from primary to secondary is the same,

VD.

power input to the primary winding
= power output from the secondary windg.

ie $V_1 I_1 \cos \phi_1 = V_2 I_2 \cos \phi_2$

Assuming $\cos \phi_1 = \cos \phi_2$,

$$V_1 I_1 = V_2 I_2.$$

For an ideal Transformer. on no load,

$$\frac{E_2}{E_1} = \frac{V_2}{V_1}$$

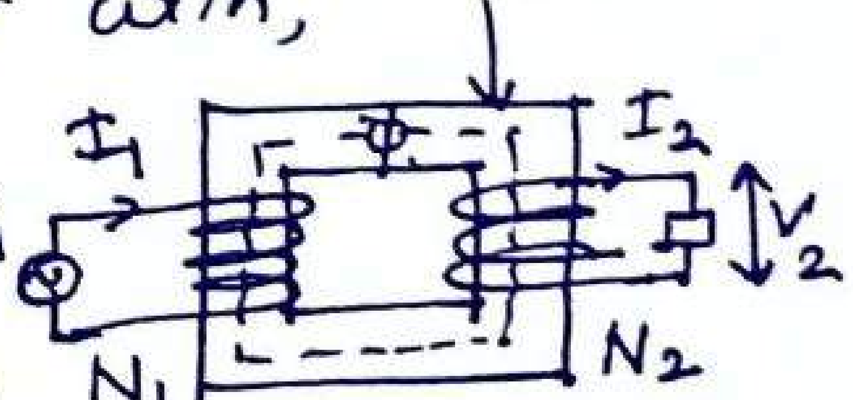
$$\therefore \frac{E_2}{E_1} = \frac{V_2}{V_1} = k.$$

But $\dfrac{V_2}{V_1} = \dfrac{I_1}{I_2} = k.$

$$\therefore \boxed{\frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} = k.}$$

E. m. f. equation of a Transformer.

Consider a single phase transformer with,



N_1 = No. of turns on primary

N_2 = No. of turns on secondary

ϕ_m = Maximum flux in the core in wb.

$\phi_m = B_m \times A$. where,

B_m = Maxm. flux density in wb/m^2.

A = Area of the core in m^2.

$f \rightarrow$ frequency of the supply in Hz.

when an alternating voltage $v_1 = V_m \sin\omega t$ is applied to the primary winding, the alternating current i_1 flows through the primary windg. and produces an alternating flux ϕ which links both primary and secondary windings. Hence an emf e_1 is induced in primary windg. and an emf e_2 is induced in secondary windg. Since the voltage v_1 and current i_1 are both sinusoidal, flux ϕ is also sinusoidal in nature. So, The equation for the flux is,

$$\phi = \phi_m \sin\omega t.$$

According to Faraday's laws of E.M.I., the induced emf e_1 is,

$\cos\omega t = \sin(90 - \omega t)$

$-\cos\omega t = \sin(\omega t - 90)$

$$e_1 = -N_1 \frac{d\phi}{dt}$$

$$= -N_1 \frac{d}{dt}(\phi_m \sin\omega t)$$

$$e_1 = -N_1 \omega \phi_m \cos\omega t.$$

$$= -2\pi f N_1 \phi_m \cos\omega t.$$

$$e_1 = 2\pi f N_1 \phi_m \sin(\omega t - 90^\circ) \quad -(1)$$

e_1 is maxm. when $\sin(\omega t - 90^\circ)$ is maxm. $= 1$.

$$\therefore e_1 = E_{m1} = 2\pi f N_1 \phi_m (1). \quad -(2)$$

Substg (2) in (1) $e_1 = E_{m1} \sin(\omega t - 90^\circ)$

where $E_{m1} = 2\pi f N_1 \phi_m$. is the maximum value of e.m.f induced in primary.

$\therefore$ Rms value of induced emf = $E_1 = \frac{E_{m1}}{\sqrt{2}}$

$$E_1 = \frac{2\pi f N_1 \phi_m}{\sqrt{2}}$$

$$\therefore \quad E_1 = \underline{4.44 f N_1 \phi_m} \quad \text{volts.}$$

This is the equation for the r.m.s value of induced e.m.f in the primary winding.

IIIly, The R.m.s. value of emf induced in the secondary winding is

$$E_2 = 4.44 f \phi_m N_2 \quad \text{volts}$$

Also, $E_1 = 4.44 f B_m A N_1$ volts.

$E_2 = 4.44 f B_m A N_2$ volts

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = k. \left[\text{ie } \frac{4.44 f \phi_m N_2}{4.44 f \phi_m N_1} = k. \right]$$

$\Rightarrow$ transformation ratio.

Emf induced /turn in primary $= \frac{E_1}{N_1} = \frac{4.44 f \phi_m N_1}{N_1}$

$= 4.44 f \phi_m$

Emf / turn in secy $= \frac{E_2}{N_2} = \frac{4.44 f \phi_m N_2}{N_2}$

$= 4.44 f \phi_m$

$\therefore$ Emf / turn in primary = Emf / turn in secy.

$= \underline{4.44 f \phi_m}$

kVA → Apparent power = kilovoltampere

$$kVA = \frac{V_1 I_1}{1000} = \frac{V_2 I_2}{1000}$$

$$kVA = \frac{V_1 I_1}{10^3} = \frac{V_2 I_2}{10^3}$$

$$\therefore I_1 = \frac{kVA \times 1000}{V_1} \qquad I_2 = \frac{kVA \times 1000}{V_2}$$

$$I_1 = \frac{kVA \times 10^3}{V_1} \qquad I_2 = \frac{kVA \times 10^3}{V_2}$$

Prob(1) Given kVA = 200 kVA. $\overset{V_1}{10000V} / \overset{V_2}{400V}$, 50Hz

$N_2 = 100$. $I_1 = ?$ $I_2 = ?$ $N_1 = ?$

$\phi m = ?$ Emf / turns = ?

1) Primary & secy currents

prim. curnt $I_1 = \frac{kVA \times 10^3}{V_1} = \frac{200 \times 10^3}{10,000} = 20A$

secy curnt. $I_2 = \frac{kVA \times 10^3}{V_2} = \frac{200 \times 10^3}{400} = 500A.$

2) $N_1 = ?$ $\frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{V_2}{V_1}.$

$\frac{N_2}{N_1} = \frac{V_2}{V_1}$ $\frac{100}{N_1} = \frac{400}{10.000.} = \underline{2500}$

3) $\underline{\phi_m}$ $\quad E_1 = 4.44 f \phi_m N_1.$

$10000 = 4.44 \times 50 \times \phi_m \times 2500.$

$\phi_m = 18.2 mwb = \underline{0.0182} wb.$

4) $\text{Emf} / \text{turn} = \dfrac{E_1}{N_1} = \dfrac{E_2}{N_2}$

$= \dfrac{10\,000}{2500} = \dfrac{400}{100} =$

$\text{Emf} / \text{turn} = \underline{4 = 4}$

---

(2) A 10 KVA, single phase tr. has 400 primary turns and 1000 secy turns. The net cross sectional area of the core is 60 cm². When the primary winding is connected to a 500V, 50Hz supply, calculate (1) Maximum value of flux density in the core 2) the voltage induced in the secy. windg. (3) the secy. full load currt.

Given: KVA = 10KVA. $N_1 = 400, N_2 = 1000.$ $A = 60 cm^2 = 60 \times 10^{-4} m^2.$

$V_1 = 500V$, 50Hz.

(1) Flux density B_m. $\quad E_1 = 4.44 f \phi_m N_1 = 500V.$

$E_1 = 4.44 f B_m A N_1. \quad \therefore B_m = \dfrac{500}{4.44 \times 50 \times 60 \times 10^{-4} \times 400}$

$B_m = 0.938 \; wb/m^2 = \boxed{0.938 \text{ Tesla}}$

2) $\underline{E_2}$ $\quad \dfrac{E_2}{E_1} = \dfrac{N_2}{N_1} \quad \therefore \boxed{E_2 = 1250V}$

$E_2 = \dfrac{N_2}{N_1} \times E_1 = \dfrac{1000}{400} \times 500.$

(3) $I_2 = \dfrac{KVA \times 10^3}{E_2}.$

$= \dfrac{10 \times 10^3}{1250.}$

$\boxed{I_2 = 8A}$

(8). A 125 kVA transformer has a primary voltage of 2000V at 60Hz. Primary turns are 182 and the secondary turns are 40. Neglecting losses, calculate: (i) No load secondary emf (ii) Full load primary & secy. currents. (iii) Flux in the core. (iv) Voltage induced per turn.

Given KVA = 125 kVA. $V_1 = 2000V$, $f = 60Hz$.

$N_1 = 182$ $N_2 = 40$. i) $E_2 = ?$ (ii) $I_1, I_2 = ?$ Emf/turn = ? $\phi = ?$

(i) No load secy emf (E_2)

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} \Rightarrow \frac{E_2}{2000} = \frac{40}{182} \quad \therefore E_2 = \underline{439.6V}$$

(ii) Full load currents

I_1 (primary F.L. currt.) $= \frac{KVA \times 10^3}{V_1}$

$$= \frac{125 \times 10^3}{2000} = \underline{62.5A}$$

I_2 (secy. F.L. currt) $= \frac{KVA \times 10^3}{V_2} = \frac{125 \times 10^3}{439.6} = \underline{284.4A}$

(iii) Flux $E_1 = 4.44 f \phi_m N_1$

$2000 = 4.44 \times 50 \times \phi_m \times 182.$

$\therefore \phi_m = 0.0412 wb$

$= \underline{41.2} mwb$

$\frac{E_2}{N_2} = \frac{439.6}{40.}$

$= \underline{10.99V/turn.}$

(iv) Voltage/turn $= \frac{E_1}{N_1} = \frac{2000}{182} = \underline{10.99V / turn}$

V.D.

(4) A single phase transfr. has 300 primary and 750 secy turns. The net cross-sectional area of the core is 64 sq. cm. If the primary voltage is 440V, at 50Hz, and rating of the tr. is 10 kVA, find (1) the maxm. flux density in the core. & (2) the emf induced in the secondary.

Given $N_1 = 300$. $N_2 = 750$. $A = 64$ sq cm $= 64 cm^2 = 64 \times 10^{-4} m^2$.

$V_1 = 440V$. $f = 50Hz$. $kVA = 10kVA$

(1) Maxm Flux density (Bm)

$$E_1 = 4.44 f B_m A N_1 \cdot \simeq V_1$$

$$440 = 4.44 \times 50 \times B_m \times 64 \times 10^{-4} \times 300.$$

$$B_m = 1.0322 \, wb/m^2 = \underline{1.0322} \text{ Tesla}$$

(2) The emf in the secy. E_2.

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}.$$

$$E_2 = E_1 \times \frac{N_2}{N_1} = 440 \times \frac{750}{300}$$

$$E_2 = \underline{1100V}$$

Power losses in a Transformer

The losses in a transformer are:

1. Core loss or Iron loss or constant loss (W_i).
2. Copper loss or Variable loss (W_{cu})

1. Core loss or Iron loss

This loss occurs in the core of the transformer and hence is known as core loss or iron loss. There are two parts - (a) Eddy current loss (b) Hysteresis loss.

(a) Eddy current loss (W_e)

This occurs due to the flow of eddy currents in the laminations of the core. They are the currents induced in the laminations due to alternating flux set up in the core, because of the primary current I_1. The power required to maintain these eddy currents is dissipated as heat and is called eddy current loss. This loss is given by Steinmetz formula,

$$W_e = \eta_e . B_m^2 f^2 t^2 V \text{ watts.}$$

where, $\eta_e \rightarrow$ constant known as Steinmetz ~~const~~ ~~constant~~. constant and its value depends on the quality of the material used for the core.

$B_m \rightarrow$ maxm. flux density in the core - wb/m^2.

$f \rightarrow$ frequency of the supply in Hz.

$t \rightarrow$ thickness of the laminations in mts.

$V \rightarrow$ volume of the core in m^3.

Hysteresis loss (Wh)

This loss occurs due to the reversal of magnetisation of the core. Since the flux in the core is alternating, the power is required to maintain continuous reversals of magnetisations (from N to S and S to N) of the core. This power is dissipated in the form of heat and is known as Hysteresis loss. It is given by,

$$Wh = \eta_h . B_m^{1.6} f V \text{ watts}$$

where, $\eta_h \rightarrow$ a constant known as hysteresis coefficient and it depends on the quality of the magnetic material.

(B_m, f & V are as stated above.)

The hysteresis loss reduced by using the material having high permeability and low hysteresis coefficient. Hence Silicon steel is used for core.

The eddy current loss is reduced by laminating the core. Due to this the resistance of the core is increased and the quantity of currents in the core is decreased.

Hence, the total Iron loss $W_i = W_h + W_e$ and is known as constant loss.

Copper loss (W_{cu})

This occurs due to the resistances of primary and secondary windings. ie R_1 & R_2 respectively. Theseare the ohmic losses occuring in the 2 windings due to I_1 flowing through R_1 and I_2 flowing through R_2.

Total copper losses W_{cu} = copper loss in primary + copper loss in secondary.

$$W_{cu} = I_1^2 R_1 + I_2^2 R_2 \text{ watts}$$

$$= I_1 R_1 + I_1^2 R_2' = I_1^2 (R_1 + R_2')$$

where $R_2' = \frac{R_2}{k^2}$.

$$W_{cu}. = I_1^2 R_{01}.$$

Also, $W_{cu} = I_2^2 R_2 + I_2^2 R_1'$.

$$= I_2^2 (R_2 + R_1') = I_2^2 R_{02}$$

where $R_1' = R_1 k^2$

$$= I_2^2 R_{02}$$

where R_{01} → equivalent resist of the transformer as referred to primary side.

& R_{02} → equivalent resistance of the transfr. as referred to secy: side

Why Copper loss is variable loss and Iron loss is a constant loss

1) The copper loss $\propto I_2^2$.

∴ It varies as the square of the load current

∴ It varies with the load current

∴ It is a variable loss

2) The Iron loss $W_i = W_e + W_h$

$\propto B_m^2 f^2 + B_m^{1.6} f$.

∴ $W_i \propto B_m f$

$\propto$ supply voltage.

Since the flux density (B_m) and frequency (f) depends on the voltage applied, as long as the supply voltage V is constant, B_m and f are constant. Hence Iron loss is constant since it does not vary with the variations in load current I_2.

∴ Iron loss is constant loss.

5

Aug 2008

3. A 600 kVA, 1ϕ transformer has an efficiency of 92% both at full load and half full load u.p.f. Detmn. its effcy. at 75% of full load, 0.9 p.f lag.

Given: kVA = 600 kVA. $\eta = 0.92$ for $x = 1$ & $x = 0.5$, $\cos\phi = 1$.

$\eta_{0.75} = ?$ at 0.9 p.f.

① η at full load, $\cos\phi = 1$. $= 0.92$.
$(x=1)$

$$\% \eta_1 = 92 = \frac{x \text{ kVA} \cos\phi \times 10^3 \times 100}{x \text{ kVA} \cos\phi \times 10^3 + W_i + x^2 W_{cu}}$$

$$0.92 = \frac{1 \times 600 \times 1 \times 10^3}{1 \times 600 \times 1 \times 10^3 + W_i + 1^2 W_{cu}}$$

$$0.92 = \frac{600 \times 10^3}{600 \times 10^3 + W_i + W_{cu}}$$

$$600 \times 10^3 + W_i + W_{cu} = \frac{600 \times 10^3}{0.92}$$

$$W_i + W_{cu} = \frac{600 \times 10^3}{0.92} - 600 \times 10^3$$

$$\underline{W_i + W_{cu} = 52.17 \text{ kW}} \quad -(1)$$

② $\eta = 92$ at half full load, upf.

$$\eta_{0.5} = 0.92 = \frac{0.5 \times 600 \times 1 \times 10^3}{0.5 \times 600 \times 1 \times 10^3 + W_i + (0.5)^2 W_{cu}}$$

$$300 \times 10^3 + W_i + 0.25 W_{cu} = \frac{300 \times 10^3}{0.92}$$

$$W_i + 0.25 W_{cu} = \frac{300}{0.92} \times 10^3 - 300 \times 10^3$$

$W_i + 0.25 W_{cu} = 26.1$ kw − (2)

$W_i + W_{cu} = 52.2$ kw − (1)

(1) −(2) gives, $0.75 W_{cu} = 26.1$ kw.

$$\therefore W_{cu} = \frac{26.1}{0.75} = \boxed{34.8 \text{ kw}}$$

$W_i = 52.2$ kw − 34.8 kw

$$\boxed{W_i = 17.4 \text{ kw}}$$

(3) η at 75% full load & 0.9 p.f.

$x = 0.75 \quad \cos\phi = 0.9.$

$$\% \eta_{0.75} = \frac{0.75 \times 600 \times 0.9 \times 10^3 \times 100}{0.75 \times 600 \times 0.9 \times 10^3 + 17.4 \times 10^3 + (0.75)^2 (34.8k)}$$

$$= \eta_{0.75} = \frac{405 \times 10^3 \times 100}{405 \times 10^3 + 36975}$$

$$\eta_{0.75} = \underline{\underline{91.6\%}}$$

(4) A 25 kVA transformer has an efficiency of 94% at full load unity p.f. and at half full load, 0.9 p.f. Detmn. the Iron loss and full load cu loss.

Given: kVA = 25 kVA $\eta = 0.94 \rightarrow x = 1$ $\cos\phi = 1$

$W_i = ?$ $W_{cu} = ?$ (F.L. cu loss) $\eta = 0.94$ $x = 0.5$, $\cos\phi = 0.9$

(1) $\eta = 0.94$ at full load, upf. $x = 1$ $\cos\phi = 1$.

$$\eta_x = \frac{x \, kVA \cos\phi \times 10^3}{x \, kVA \cos\phi \times 10^3 + W_i + x^2 W_{cu}} \times 100$$

$$0.94 = \frac{1 \times 25 \times 1 \times 10^3}{1 \times 25 \times 1 \times 10^3 + W_i + 1^2 (W_{cu})}$$

$$25 \times 10^3 + W_i + W_{cu} = \frac{25 \times 10^3}{0.94}$$

$$W_i + W_{cu} = \frac{25 \times 10^3}{0.94} - 25 \times 10^3 =$$

$W_i + W_{cu} = 1595.74$ watts. —(1)

(2) $\eta = 0.94$ at 1/2 F.L. 0.9 p.f. $x = 0.5$ & $\cos\phi = 0.9$.

$$0.94 = \frac{0.5 \times 25 \times 0.9 \times 10^3}{0.5 \times 25 \times 0.9 \times 10^3 + W_i + (0.5)^2 W_{cu}}$$

$$0.5 \times 25 \times 0.9 \times 10^3 + W_i + 0.25 W_{cu} = \frac{0.5 \times 25 \times 0.9 \times 10^3}{0.94}$$

$W_i + 0.25 W_{cu} = 718.08$ W. —(2)

$W_i + W_{cu} = 1595.74$ W —(1)

F.L. culoss. $\boxed{W_{cu} = 1170.21 \text{ W}}$ $\boxed{W_i = 425.53 \text{ W}}$

(5). A 40kVA 1ϕ tr. has core loss of 450W and full load Copper loss of 850W. If the p.f of the load is 0·8, calculate :

(1) Full load efficiency.

(2) Load for maxm. efficiency.

(3) Efficiency at the above load. (Maxm effcy)

Given. kVA = 40 kVA. Wi = 450W. Wcu = 850W.

$\cos\phi = 0{\cdot}8$.

(1) Full load effcy. $x = 1$, $\cos\phi = 0.8$

$$\%\eta_x = \frac{x \text{ kVA} \cos\phi \times 10^3 \quad \times 100}{x \text{ kVA} \cos\phi \times 10^3 + W_i + x^2 W_{cu}}$$

$$\%\eta_1 = \frac{1 \times 40 \times 0{\cdot}8 \times 10^3 \quad \times \quad 100}{1 \times 40 \times 0{\cdot}8 \times 10^3 + 450 + 1^2 \times 850}$$

$\eta_1 = \underline{\underline{96{\cdot}1\ \%}}$

(2) Load at which maxm effcy occurs

$$(\text{kVA})_{\eta\, max} = \text{Full load kVA} \sqrt{\frac{W_i}{\text{F.L. cu loss}}}$$

$$= 40\sqrt{\frac{450}{850}} =$$

$$(\text{Load kVA})_{\text{at maxm effcy}} = \underline{\underline{29{\cdot}1}}\ \text{kVA}$$

(7.) In a 25 KVA, 2000/200V 1φ transformer the Iron loss & full load cu losses are 350w and 400 w resply. Calculate 1) The load at which the effcy is maxm. 2) Maxm effcy. at 0.8 p.f.

KVA = 25 KVA. W_i = 350W. W_{cu} = 400W.

1) The load at which the effcy is maxm.

$$(\text{Load KVA})_{\eta \max} = \text{F.L. KVA}\sqrt{\frac{W_i}{\text{F.L. cu loss}}}$$

$$= 25\sqrt{\frac{350}{400}} = \underline{\underline{23.38\ \text{KVA}}}$$

2) Maximum effcy

$$(x\ \text{KVA})\ \eta_{\max} = 23.38\ \text{KVA}. \quad \cos\phi = 0.8.$$

$$W_i = x^2 W_{cu} = 350\,W.$$

$$\eta_{\max} = \frac{23.38 \times 0.8 \times 10^3}{23.38 \times 0.8 \times 10^3 + 350 + 350} \times 100$$

$$\eta_{\max} = \underline{\underline{96.39}}\ \%.$$

or. $$x = \frac{23.38}{25} = 0.9352.$$

at $\eta_{\max}$

$$\eta_{\max} = \frac{0.9352 \times 25 \times 0.8 \times 10^3}{0.9352 \times 25 \times 0.8 \times 10^3 + 350 + (0.9352)^2 \times 400} \times 100$$

$$\eta_{\max} = 96.39\%.$$

Efficiency at the above load = Maximum effcy.

η_{max} happens at a load kVA of 29.1 kVA.

$\therefore$ (x kVA) at maxm. effcy = 29.1 kVA

Also, $x^2 W_{cu} = W_i$ at η_{max}.

$$\eta_{max} = \frac{x\ kVA \cos\phi \times 10^3}{x\ kVA \cos\phi \times 10^3 + W_i + W_i} \times 100$$

$$= \frac{29.1 \times 0.8 \times 10^3}{29.1 \times 0.8 \times 10^3 + 2(450)} \times 100 = \frac{23280}{24180} \times 100$$

$\eta_{max} =$ 96.27 %.

---

or, at η_{max}, kVA = 29.1 kVA.

$$x = \frac{\text{Actual load kVA at } \eta_{max}}{\text{Full load kVA}}$$

$$x = \frac{29.1}{40} = 0.7275$$

$$\therefore \eta_{max} = \frac{0.7275 \times 40 \times 10^3 \times 0.8}{0.7275 \times 40 \times 0.8 \times 10^3 + 450 + (0.7275)^2 \times 800} \times 100$$

$\eta_{max} =$ 96.27 %.

7) A single phase 25 kVA, 1000/2000V, 50Hz tr. has maxm. effcy of 98% at full load u.p.f. Detmn. its effcy at 1) 3/4 full load upf (2) 1.25 full load, 0.9 p.f

$$\eta_x = \frac{x \, kVA \cos\phi \times 10^3}{x \, kVA \cos\phi \times 10^3 + W_i + x^2 W_{cu}} \times 100$$

At maxm. effcy, $W_i = x^2 W_{cu}$. $x = 1$. $\cos\phi = 1$.

$$\therefore 0.98 = \frac{1 \times 25 \times 10^3 \times 1}{1 \times 25 \times 1 \times 10^3 + 2W_i}$$

$$= 25 \times 10^3 + 2W_i = \frac{25 \times 10^3}{0.98}$$

$2W_i = 510.2$ watts

$\therefore W_i = 255.1$ W, $x^2 W_{cu} = W_i =$

$1^2 W_{cu} = 255.1$

$\therefore$ Full load cu loss, $W_{cu} = 255.1$ W

1) η at 3/4 full load up.f $x = 3/4$ $\cos\phi = 1$.

$$= \eta_{0.75} = \frac{0.75 \times 25 \times 1 \times 10^3}{0.75 \times 25 \times 1 \times 10^3 + 255.1 + 1^2(255.1)} \times 100$$

$\eta = 97.92\%$.

2) η at 1.25 full load, 0.9 p.f.

$$\eta_{1.25} = \frac{1.25 \times 25 \times 0.9 \times 10^3}{1.25 \times 25 \times 0.9 \times 10^3 + 255.1 + (1.25)^2 (255.1)} \times 100.$$

$\eta = 97.73\%$

(8). The maxm. effcy at full load and upf of a 1ϕ, 25kVA, 500/1000V, 50Hz transformer is 97.5%. Detmn. the effcy at (1) 75% load, 0.9 p.f (2) 50% load, 0.8pf (3) 25% load and 0.6 p.f.

KVA = 25 $W_i = x^2 W_{cu}$.

$x = 1$ $\cos\phi = 1$.

(1) $\eta_{max} = 0.975$.

$$0.975 = \frac{1 \times 25 \times 1 \times 10^3}{1 \times 25 \times 1 \times 10^3 + 2W_i}$$

$$2W_i + 25 \times 10^3 = \frac{25 \times 10^3}{0.975} = \underline{641.02W}$$

$\underline{2W_i = 641.02W}$ ∴ $W_i = \underline{320.5W}$

$x^2 W_{cu} = W_i = 320.5W$. $1^2 W_{cu} = \underline{320.5W}$

$$1)\ \eta_{0.75} = \frac{0.75 \times 25 \times 0.9 \times 10^3}{0.75 \times 25 \times 0.9 \times 10^3 + 320.5 + 0.75^2 \times 320.5} \times 100.$$

$\eta = 97.11\%$.

$$2)\ \eta_{0.5} = \frac{0.5 \times 25 \times 0.8 \times 10^3}{0.5 \times 25 \times 0.8 \times 10^3 + 320.5 + 0.5^2 \times 320.5} \times 100$$

$\eta = 96.14\%$

$$(3)\ \eta_{0.25} = \frac{0.25 \times 25 \times 0.6 \times 10^3}{0.25 \times 25 \times 0.6 \times 10^3 + 320.5 + (0.25)^2\ 320.5} \times 100$$

$$\eta = \frac{3750}{3750 + 340.53} = \underline{91.68\%}$$ | 340.53.

Efficiency of a Transformer and Condition for maximum efficiency

The efficiency of a transformer at any load and p-f is defined as the ratio of the power output at the secondary winding to the power input to the primary winding.

i.e. Efficiency $\eta = \frac{\text{power output in watts}}{\text{power input in watts}}$

Power input = $V_1 I_1 \cos\phi_1$.

where $V_1 \rightarrow$ primary applied voltage.

$I_1 \rightarrow$ primary current.

$\cos\phi_1 \rightarrow$. power factor of primary current.

$$\text{Effcy. } \eta = \frac{\text{power input} - \text{losses}}{\text{power input}}$$

$$\eta = \frac{\text{power input} - \text{Cu losses} - \text{Iron losses}}{\text{Power input}}$$

$$\eta = \frac{V_1 I_1 \cos\phi_1 - I_1^2 R_{01} - W_i}{V_1 I_1 \cos\phi_1}$$

where Cu loss = $I_1^2 R_{01}$ W_i = Iron loss.

$$\eta = \frac{V_1 I_1 \cos\phi_1 - I_1^2 R_{01} - W_i}{V_1 I_1 \cos\phi_1 .}$$

$$\eta = 1 - \frac{I_1^2 R_{01}}{V_1 I_1 \cos\phi_1} - \frac{W_i}{V_1 I_1 \cos\phi_1}$$

Condition for Maximum efficiency.

The efficiency is maximum when $\frac{d\eta}{dI_1} = 0$.

∴ The condition for maxm. effey is obtained by equating $\frac{d\eta}{dI_1} = 0$.

$$\text{ie } \frac{d\eta}{dI_1} = \frac{d}{dI_1}\left(1 - \frac{I_1^2 R_{01}}{V_1 I_1 \cos\phi_1} - \frac{W_i}{V_1 I_1 \cos\phi_1}\right) = 0.$$

$$= \frac{d}{dI_1}\left(1 - \frac{I_1 R_{01}}{V_1 \cos\phi_1} - \frac{W_i}{V_1 I_1 \cos\phi_1}\right) = 0.$$

$$\frac{d\eta}{dI_1} = 0 - \frac{R_{01}}{V_1 \cos\phi_1} - \frac{W_i}{V_1 (I_1^2) \cos\phi_1} = 0.$$

$$\text{or, } \frac{R_{01}}{V_1 \cos\phi_1} - \frac{W_i}{V_1 \cos\phi_1 (-I_1^2)} = 0.$$

$$\frac{R_{01}}{\cancel{V_1 \cos\phi_1}} = \frac{W_i}{(\cancel{V_1 \cos\phi_1}) I_1^2} \quad \therefore I_1^2 R_{01} = W_i$$

$$\text{or } \boxed{W_i = W_{cu}}$$

$\therefore$ $W_i = W_{cu}$ } is the condition for

ie $\boxed{\text{Iron loss} = \text{Cu loss}}$ } Maximum efficiency.

ie $W_i = W_{cu} = I_1^2 R_{01} = I_2^2 R_{02}$.

or, $W_i = I_2^2 R_{02}$.

The load current at Maxm. efficy $(I_2)_{\eta max} = \sqrt{\dfrac{W_i}{R_{02}}}$

Load kVA at Maximum efficiency

Let W_i = Iron loss at full load.

W_{cu} = Copper loss at full load.

$W_{cu} = I_2^2 R_{02}$. But $I_2 = \dfrac{KVA \times 10^3}{V_2}$.

$\therefore$ $I_2 \propto KVA$

$\therefore$ Copper loss $W_{cu} \propto I_2^2 \propto (KVA)^2$.

Let copper loss at x fraction of load $= (W_{cu})_x$.

$(W_{cu})_x = (x I_2)^2 R_{02} = (x\,KVA)^2 R_{02}$

$(W_{cu})_x = x^2 (KVA)^2 R_{02}$.

$(W_{cu})_x \propto x^2 (F.L.\ KVA)^2$.

If the effcy is maxm. at x load,

Iron loss = Cu loss at x load.

ie at η_{max}, $W_i = (W_{cu})_x \; \alpha \; x^2 (F.L.\,kVA)^2$

$$\therefore \; W_i \; \alpha \; x^2 (F\text{-}L\; kVA)^2 \quad \text{—(1)}$$

Cu loss at Full load, $W_{cu} \; \alpha \; (F\text{-}L\cdot kVA)^2$ —(2)

$\frac{(1)}{(2)}$, gives, $\frac{W_i}{W_{cu}} = \frac{x^2 (F\text{-}L\; kVA)^2}{(F\;L\;kVA)^2}$

$$\therefore \; \frac{W_i}{W_{cu}} = x^2$$

But $x = \frac{\text{Actul load kVA at } \eta_{max}}{\text{Full load kVA}}$

$$\frac{W_i}{W_{cu}} = x^2$$

$$x = \sqrt{\frac{W_i}{W_{cu}}}$$

$$\frac{(\text{Actual load kVA})\,\eta_{max}}{\text{Full load kVA}} = \sqrt{\frac{W_i}{W_{cu}}}$$

$$\therefore \; (\text{Actual load kVA})\,\eta_{max} = F\cdot L\; kVA \sqrt{\frac{W_i}{W_{cu}}}$$

or. $$(\text{Load KVA})_{\eta_{max}} = \text{F.L. KVA} \sqrt{\frac{\text{Iron loss}}{\text{Cu loss at Full load}}}$$

$$\text{Load KVA at maxm effey} = \text{F.L KVA} \sqrt{\frac{\text{Iron loss}}{W_{cu} \text{ at F.L}}}$$

|||ly, Load current

$$I_2 \text{ at } \eta_{max} = I_2 \sqrt{\frac{W_i}{W_{cu} \text{ at F.L}}}$$

$$\boxed{(I_2)_{\eta_{max}} = (I_2 \text{ at F.L}) \sqrt{\frac{W_i}{W_{cu} \text{ at F.L}}}}$$

$$\boxed{(\text{Load KVA})_{\eta_{max}} = \text{F.L. KVA} \sqrt{\frac{W_i}{W_{cu} \text{ at F.L}}}}$$

The efficiency at any load x is,

$$\eta_x = \frac{\text{output}}{\text{Input}} = \frac{\text{output in watts}}{\text{output + Losses.}} = \frac{\text{o/p in watts}}{\text{o/p} + W_i + W_{cu}}$$

$$\%.\eta_x = \frac{x \text{ KVA} \cos\phi \times 10^3}{x \text{ KVA} \cos\phi \times 10^3 + W_i + x^2 W_{cu}} \times 100$$

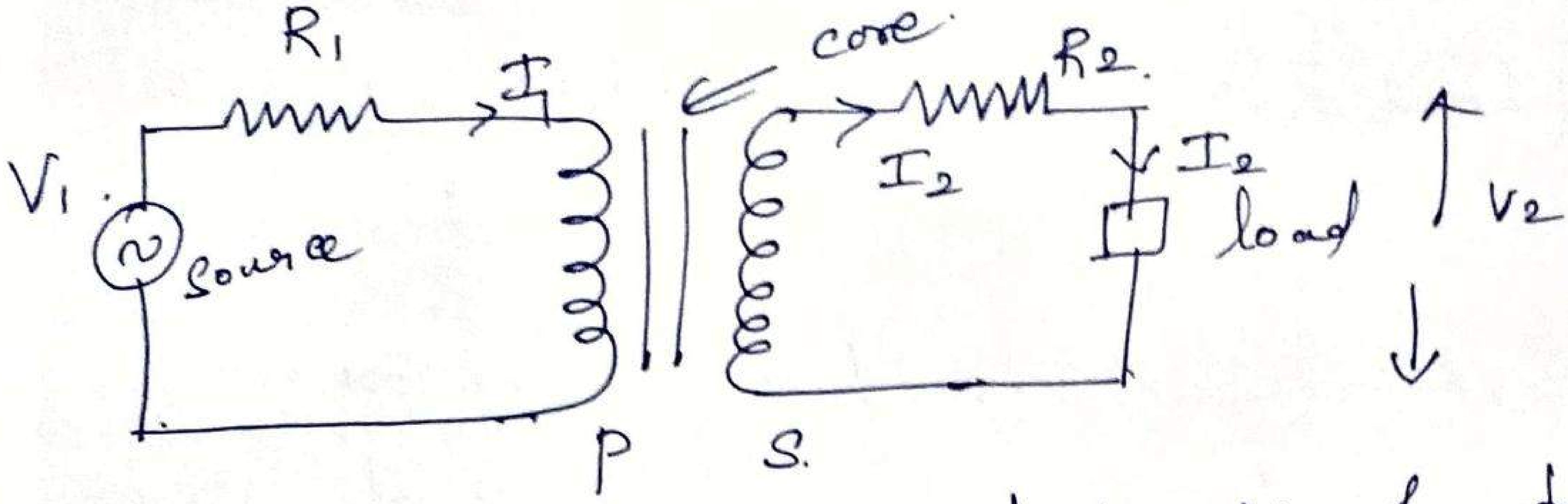
where $x \Rightarrow$ fraction of the full load

At 50% of full load, $x = \frac{50}{100} = 0.5$

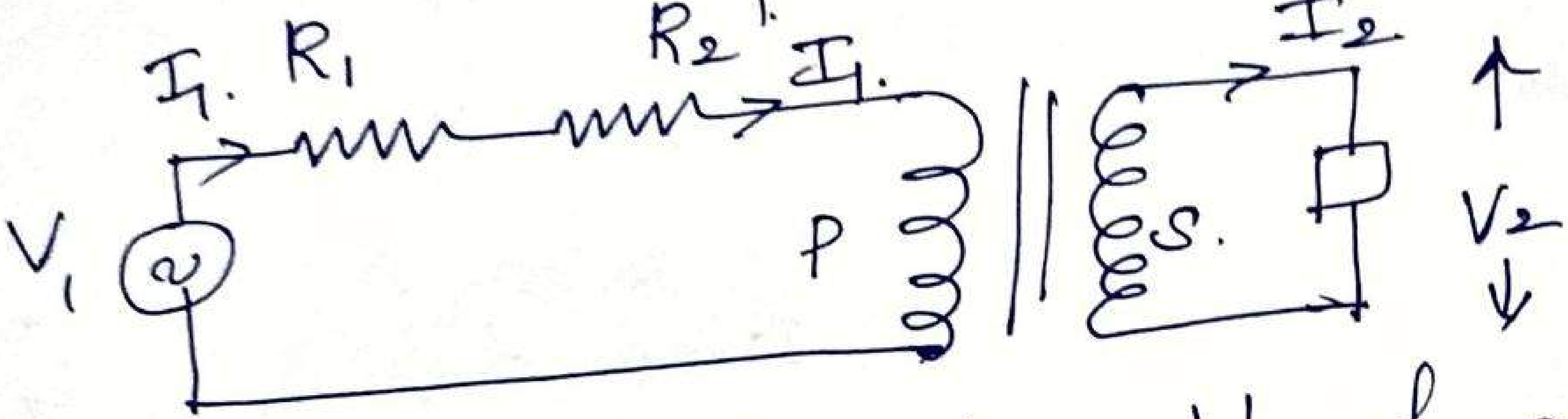
At 75% of full load, $x = \frac{75}{100} = 0.75$

$\cos\phi$ = load p.f & $W_{cu} \Rightarrow$ full load cu loss.

Equivalent ckts of a Transformer



Exact equivalent ckt of a transformer



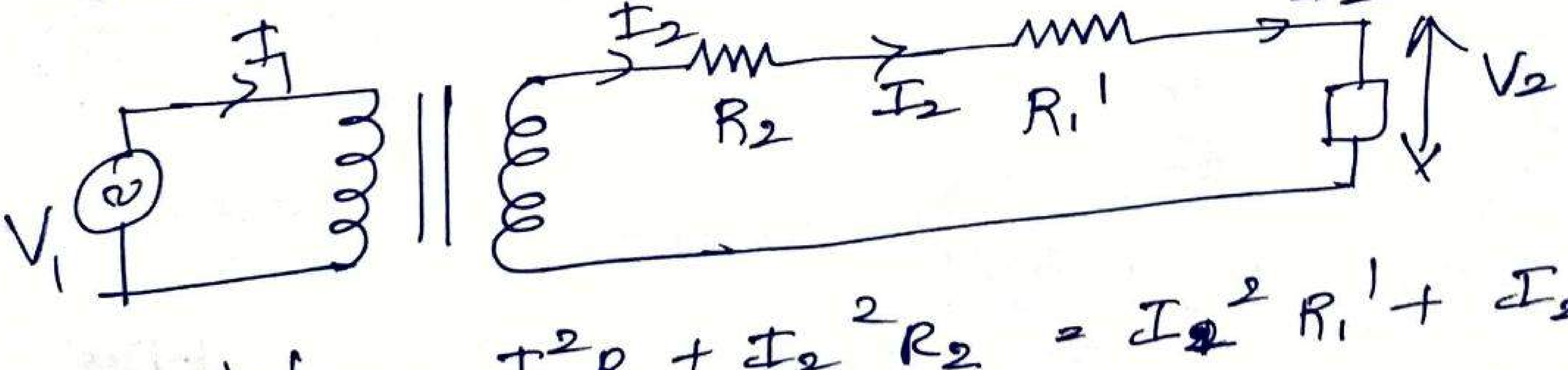
Approximate eqt. ckt of a transformer

R_2 is shifted to primary side.

$W_{cu} = I_1^2 R_1 + I_2^2 R_2 = I_1^2 R_1 + I_1^2 R_2'$.

$= I_1^2 (R_1 + R_2') = \underline{I_1^2 R_{01}}$ where $R_2' = \frac{R_2}{k^2}$

$\boxed{W_{cu} = I_1^2 R_{01}}$ where R_{01} is eqt. resist. of the transformer referred to primary.



$W_{cu} = I_1^2 R_1 + I_2^2 R_2 = I_2^2 R_1' + I_2^2 R_2$.

where $R_1' = R_1 k^2$. $W_{cu} = I_2^2 (R_1' + R_2)$

$\therefore \boxed{W_{cu} = I_2^2 R_{02}}$

$R_{02} \rightarrow$ eqt. resist. of the tr. referred to secondary.

(1) In a 25 kVA, 2000/200 V transformer the Iron and copper losses are 850 watts and 400 w respectively. Calculate the efficiency at u.p.f. on (1) full load (2) half full load.

Given. kVA = 25 kVA. 2000/200V.

Wi = 350 w Wcu = 400W.

$$\% \eta_x = \frac{x \, kVA \cos\phi \times 10^3}{x \, kVA \cos\phi \times 10^3 + Wi + x^2 Wcu} \times 100.$$

(1) At Full load. at u.p.f. x = 1 cosφ = 1.

$$\% \eta_1 = \frac{1 \times 25 \times 1 \times 10^3}{1 \times 25 \times 1 \times 10^3 + 350 + (1^2 \times 400)} \times 100.$$

$$\% \eta_1 = \frac{25000}{25750} \times 100 = \underline{97.08\%}$$

2.) half full load, upf. x = 0.5 cosφ = 1

$$\% \eta_{0.5} = \frac{0.5 \times 25 \times 1 \times 10^3}{0.5 \times 25 \times 1 \times 10^3 + 350 \times (0.5)^2 400} \times 100$$

$$= \underline{96.52\%}$$

2.) Determine the efficiency of a 150 kVA tr. at i) 50% full load and 0.8 p.f. (ii) 75%.

full load, 0.9 p.f., if the copper loss at full load is 1600 W. and the iron loss is 1400 W.

Given. KVA = 150 KVA $W_i = 1400W$

$W_{cu} = 1600W.$ $\eta_{0.5} = ?$ $\eta_{0.75} = ?$

(i) η at 50% of full load and 0.8 p.f.

$x = 0.5$ $\cos\phi = 0.8.$

$$\% \eta_x = \frac{x \ KVA \cos\phi \times 10^3 \times 100.}{x \ KVA \cos\phi \times 10^3 + W_i + x^2 W_{cu}.}$$

$$\% \eta_{0.5} = \frac{0.5 \times 150 \times 0.8 \times 10^3 \times 100}{0.5 \times 150 \times 0.8 \times 10^3 + 1400 + (0.5)^2 1600.}$$

$\eta_{0.5} = 97 \%$

(2) η at 75% of load & 0.9 p.f.

$x = 0.75$ $\cos\phi = 0.9.$

$$\% \eta_{0.75} = \frac{0.75 \times 150 \times 0.9 \times 10^3 \times 100}{0.75 \times 150 \times 0.9 \times 10^3 + 1400 + (0.75)^2 1600.}$$

$$\% \eta_{0.75} = \frac{101\,250.}{103\,550} \times 100$$

$\eta_{0.75} = 97.7\%$

5

Aug 2008 3. A 600 kVA, 1φ transformer has an efficiency of 92%. both at full load and half full load u.p.f. Detmn. its effcy. at 75% of full load, 0.9 p.f lag.

Given: kVA = 600 kVA. $\eta = 0.92$ for $x=1$ & $x=0.5$
$\cos\phi = 1.$

$\eta_{0.75} = ?$ at 0.9 p.f.

① η at full load $(x=1)$, $\cos\phi = 1. = 0.92.$

$$\%\eta_1 = 92 = \frac{x\ \text{kVA}\cos\phi \times 10^3 \times 100}{x\ \text{kVA}\cos\phi \times 10^3 + W_i + x^2 W_{cu}}$$

$$0.92 = \frac{1 \times 600 \times 1 \times 10^3}{1 \times 600 \times 1 \times 10^3 + W_i + 1^2 W_{cu}.}$$

$$0.92 = \frac{600 \times 10^3}{600 \times 10^3 + W_i + W_{cu}}$$

$$600 \times 10^3 + W_i + W_{cu} = \frac{600 \times 10^3}{0.92.}$$

$$W_i + W_{cu} = \frac{600 \times 10^3}{0.92} - 600 \times 10^3.$$

$$W_i + W_{cu} = 52.17\ \text{kW}. \quad -(1)$$

② $\eta = 92$ at half full load, upf.

$$\eta_{0.5} = 0.92 = \frac{0.5 \times 600 \times 1 \times 10^3}{0.5 \times 600 \times 1 \times 10^3 + W_i + (0.5)^2 W_{cu}.}$$

$$300 \times 10^3 + W_i + 0.25\ W_{cu} = \frac{300 \times 10^3}{0.92.}$$

$$W_i + 0.25 W_{cu} = \frac{300}{0.92} \times 10^3 - 300 \times 10^3$$

$W_i + 0.25 W_{cu} = 26.1$ kw — (2)

$W_i + W_{cu} = 52.2$ kw — (1)

(1) − (2) gives, $0.75 W_{cu} = 26.1$ kw.

$$\therefore W_{cu} = \frac{26.1}{0.75} = \boxed{34.8 \text{ kw}}$$

$W_i = 52.2$ kw − 34.8 kw

$$\boxed{W_i = 17.4 \text{ kw}}$$

(3) η at 75% full load & 0.9 p.f.

$x = 0.75$ $\cos\phi = 0.9$.

$$\% \eta_{0.75} = \frac{0.75 \times 600 \times 0.9 \times 10^3}{0.75 \times 600 \times 0.9 \times 10^3 + 17.4 \times 10^3 + (0.75)^2 (34.8k)} \times 100$$

$$= \eta_{0.75} = \frac{405 \times 10^3}{405 \times 10^3 + 36975} \times 100$$

$$\eta_{0.75} = 91.6\%$$

④) A 25 KVA transformer has an efficiency of 94% at full load unity p.f. and at half full load, 0.9 p.f. Detmn. the Iron loss and full load cu loss.

Given: KVA = 25 KVA. $\eta = 0.94 \rightarrow x = 1 \ \cos\phi = 1$

$W_i = ?$ $W_{cu} = ?$ (F.L. cu loss) $\eta = 0.94$ $x = 0.5, \cos\phi = 0.9$

(1) $\eta = 0.94$ at full load, u.p.f. $x = 1 \ \cos\phi = 1$.

$$\eta_x = \frac{x \, KVA \cos\phi \times 10^3}{x \, KVA \cos\phi \times 10^3 + W_i + x^2 W_{cu}} \times 100$$

$$0.94 = \frac{1 \times 25 \times 1 \times 10^3}{1 \times 25 \times 1 \times 10^3 + W_i + 1^2 (W_{cu})}$$

$$25 \times 10^3 + W_i + W_{cu} = \frac{25 \times 10^3}{0.94}$$

$$W_i + W_{cu} = \frac{25 \times 10^3}{0.94} - 25 \times 10^3 =$$

$$W_i + W_{cu} = 1595.74 \text{ watts.} \quad -(1)$$

(2) $\eta = 0.94$ at 1/2 F.L. 0.9 p.f. $x = 0.5$ & $\cos\phi = 0.9$.

$$0.94 = \frac{0.5 \times 25 \times 0.9 \times 10^3}{0.5 \times 25 \times 0.9 \times 10^3 + W_i + (0.5)^2 W_{cu}}$$

$$0.5 \times 25 \times 0.9 \times 10^3 + W_i + 0.25 W_{cu} = \frac{0.5 \times 25 \times 0.9 \times 10^3}{0.94}$$

$$W_i + 0.25 W_{cu} = 718.08 \text{ W.} \quad -(2)$$

$$W_i + W_{cu} = 1595.74 \text{ W} \quad -(1)$$

F.L. Culoss. $\boxed{W_{cu} = 1170.21 \text{ W}}$ $\boxed{W_i = 425.53 \text{ W}}$

(5). A 40 kVA 1ϕ tr. has core loss of 450 W and full load Copper loss of 850 W. If the p.f of the load is 0.8, calculate:

(1) Full load efficiency.

(2) Load for maxm. efficiency.

(3) Efficiency at the above load. (Maxm effcy)

Given. kVA = 40 kVA. Wi = 450 W. Wcu = 850 W.

$\cos\phi = 0.8$.

(1) Full load effcy. $x = 1$, $\cos\phi = 0.8$

$$\%\eta_x = \frac{x \text{ kVA} \cos\phi \times 10^3 \quad \times 100}{x \text{ kVA} \cos\phi \times 10^3 + W_i + x^2 W_{cu}}$$

$$\%\eta_1 = \frac{1 \times 40 \times 0.8 \times 10^3 \quad \times \quad 100}{1 \times 40 \times 0.8 \times 10^3 + 450 + 1^2 \times 850}$$

$$\eta_1 = \underline{\underline{96.1\ \%}}$$

(2) Load at which maxm effcy occurs

$$(\text{kVA})_{\eta \, max} = \text{Full load kVA} \sqrt{\frac{W_i}{\text{F.L. cu loss}}}$$

$$= 40 \sqrt{\frac{450}{850}} =$$

$$\left(\text{Load kVA}\right)_{\text{at maxm effcy}} = \underline{29.1 \text{ kVA}}$$

(5.) In a 25 KVA, 2000/200V 1ϕ transformer the Iron loss & full load cu losses are 350w and 400 w resply. Calculate 1) The load at which the effcy is maxm. 2) Maxm effcy. at 0.8 p.f.

KVA = 25 KVA. Wi = 350w. Wcu = 400w.

1) The load at which the effcy is maxm.

$$(\text{Load KVA})_{\eta max} = \text{F-L. KVA}\sqrt{\frac{Wi}{\text{F-L. cu loss}}}$$

$$= 25\sqrt{\frac{350}{400}} = \underline{\underline{23.38\ KVA}}$$

1) Maximum effcy

$(x\ KVA)_{\eta max} = 23.38\ KVA.$ cosϕ = 0.8.

$Wi = x^2 W_{cu} = 350\,w.$

$$\eta_{max} = \frac{23.38 \times 0.8 \times 10^3}{23.38 \times 0.8 \times 10^3 + 350 + 350} \times 100$$

$\eta_{max} = \underline{\underline{96.39\ \%}}$.

or. $x = \frac{23.38}{25} = 0.9352.$

at η_{max}

$$\eta_{max} = \frac{0.9352 \times 25 \times 0.8 \times 10^3}{0.9352 \times 25 \times 0.8 \times 10^3 + 350 + (0.9352)^2 \times 400} \times 100$$

$\eta_{max} = 96.39\%.$

Efficiency at the above load = Maximum effcy.

η_{max} happens at a load kVA of 29.1 kVA

$\therefore$ (x kVA) at maxm. effcy = 29.1 kVA

Also, $x^2 W_{cu} = W_i$ at η_{max}.

$$\eta_{max} = \frac{x \text{ kVA} \cos\phi \times 10^3}{x \text{ kVA} \cos\phi \times 10^3 + W_i + W_i} \times 100$$

$$= \frac{29.1 \times 0.8 \times 10^3}{29.1 \times 0.8 \times 10^3 + 2(450)} \times 100$$

$$= \frac{23280}{24180} \times 100$$

$\eta_{max} =$ 96.27 %.

---

or, at η_{max}, kVA = 29.1 kVA

$$x = \frac{\text{Actual load kVA at } \eta_{max}}{\text{Full load kVA}}$$

$$x = \frac{29.1}{40} = 0.7275$$

$$\therefore \eta_{max} = \frac{0.7275 \times 40 \times 10^3 \times 0.8}{0.7275 \times 40 \times 0.8 \times 10^3 + 450 + (0.7275)^2 \times 800} \times 100$$

$\eta_{max} =$ 96.27 %.

(8). The maxm. effcy at full load and upf of a 1φ, 25kVA, 500/1000V, 50Hz transformer is 97.5%. Detmn. the effcy at
(1) 75% load, 0.9 p.f (2) 50% load, 0.8pf
(3) 25% load and 0.6 p.f.

(1) η max = 0.975. KVA = 25 $W_i = x^2 W_{cu}$.
$x = 1$ $\cos\phi = 1$.

$$0.975 = \frac{1 \times 25 \times 1 \times 10^3}{1 \times 25 \times 1 \times 10^3 + 2W_i}$$

$$2W_i + 25 \times 10^3 = \frac{25 \times 10^3}{0.975} = \underline{\underline{641.02W}}$$

$2W_i = \underline{\underline{641.02W}}$ ∴ $W_i = \underline{\underline{320.5W}}$

$x^2 W_{cu} = W_i = 320.5W$. $1^2 W_{cu} = \underline{\underline{320.5W}}$

$$1)\ \eta_{0.75} = \frac{0.75 \times 25 \times 0.9 \times 10^3}{0.75 \times 25 \times 0.9 \times 10^3 + 320.5 + 0.75^2 \times 320.5} \times 100.$$

$\eta = 97.11\%$.

$$2)\ \eta_{0.5} = \frac{0.5 \times 25 \times 0.8 \times 10^3}{0.5 \times 25 \times 0.8 \times 10^3 + 320.5 + 0.5^2 \times 320.5} \times 100$$

$\eta = 96.14\%$.

$$(3)\ \eta_{0.25} = \frac{0.25 \times 25 \times 0.6 \times 10^3}{0.25 \times 25 \times 0.6 \times 10^3 + 320.5 + (0.25)^2\ 320.5} \times 100$$

$$\eta = \frac{3750}{3750 + 340.53} = \underline{\underline{91.68\%}}$$ | 340.53.

7) A single phase 25kVA, 1000/2000V, 50Hz tr. has maxm. effcy of 98%. at full load u.p.f. Detmn. its effcy at 1) 3/4 full load upf (2) 1.25 full load, 0.9 p.f

$$\eta_x = \frac{x\ kVA\cos\phi\times10^3}{x\ kVA\cos\phi\times10^3 + W_i + x^2W_{cu}}\times100$$

At maxm. effcy, $W_i = x^2 W_{cu}$. $x=1$. $\cos\phi=1$.

$$\therefore 0.98 = \frac{1\times25\times10^3\times1}{1\times25\times1\times10^3 + 2W_i}$$

$$= 25\times10^3 + 2W_i = \frac{25\times10^3}{0.98}$$

$$2W_i = \underline{510.2}\ \text{watts}$$

$\therefore W_i = \underline{255.1\ W}$, $x^2 W_{cu} = W_i =$

$1^2 W_{cu} = 255.1$

$\therefore$ Full load cu loss, $W_{cu} = \underline{255.1}\ W$

1) η at 3/4 full load u.p.f $x=3/4$ $\cos\phi=1$.

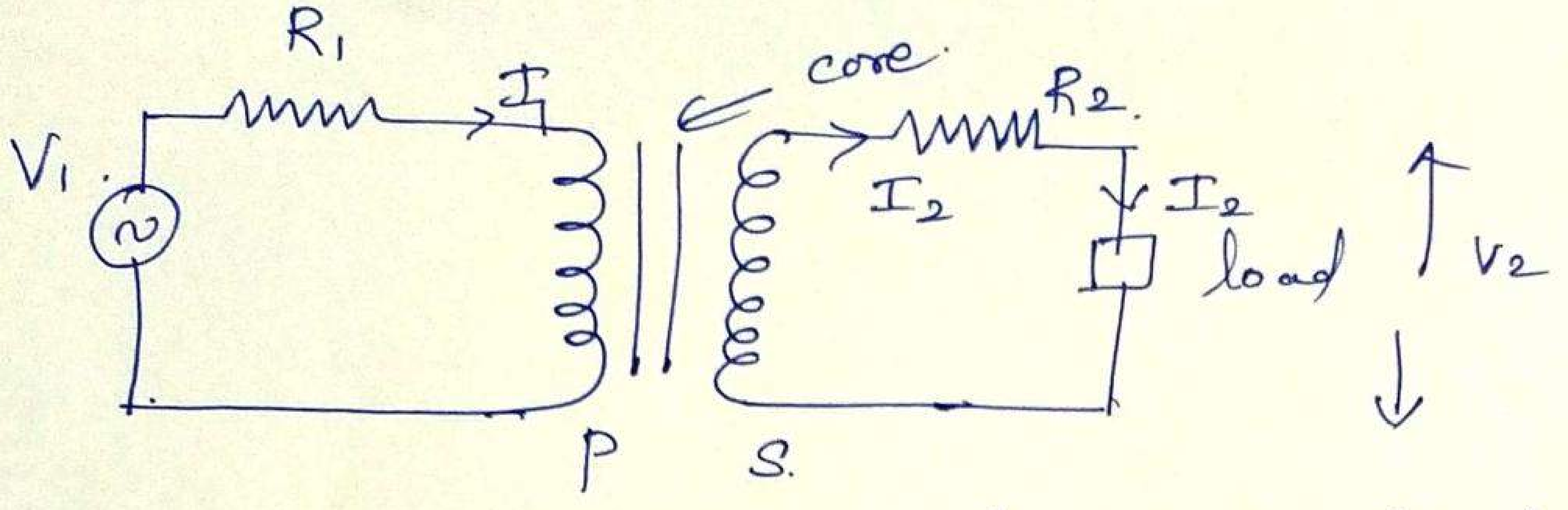
$$=\eta_{0.75} = \frac{0.75\times25\times1\times10^3}{0.75\times25\times1\times10^3 + 255.1 + 1^2(255.1)}\times100$$

$$\eta = \underline{97.92}\%$$

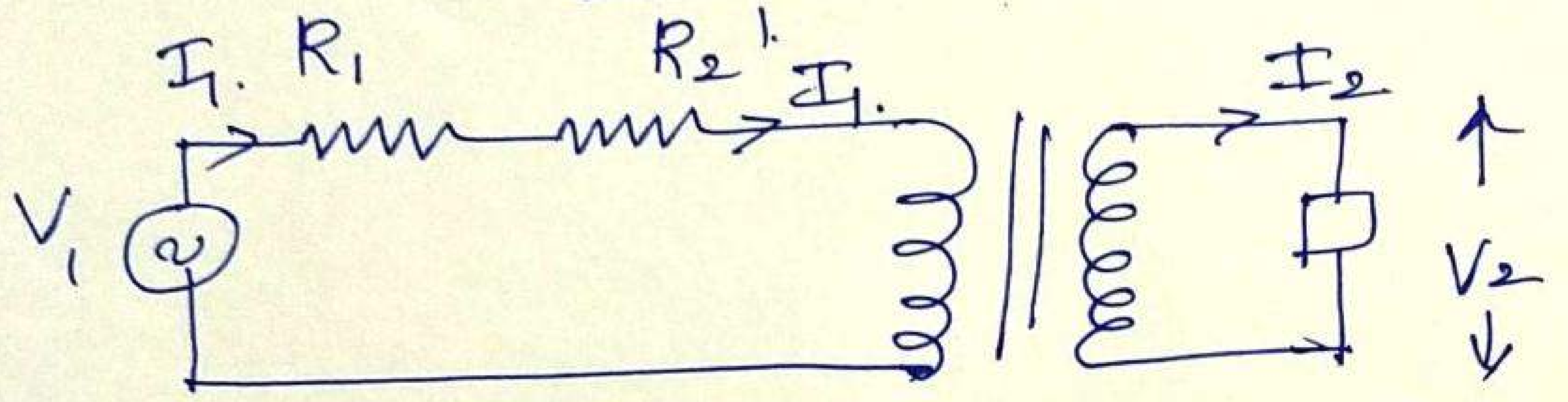
2) η at 1.25 full load, 0.9 p.f.

$$\eta_{1.25} = \frac{1.25\times25\times0.9\times10^3}{1.25\times25\times0.9\times10^3 + 255.1 + (1.25)^2(255.1)}\times100.$$

$$\eta = \underline{97.73}\%$$



Exact equivalent ckt of a transformer



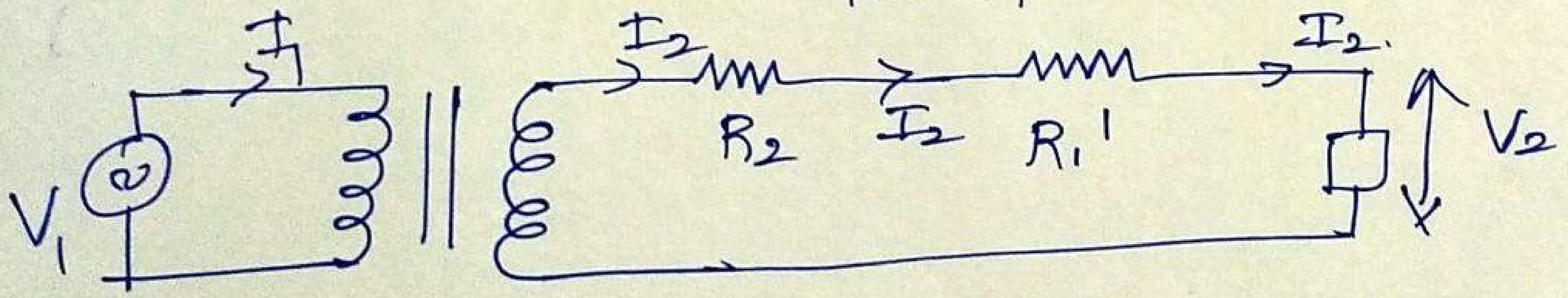
Approximate eqt. ckt of a transformer

R_2 is shifted to primary side.

$W_{cu} = I_1^2 R_1 + I_2^2 R_2 = I_1^2 R_1 + I_1^2 R_2'$.

$= I_1^2 (R_1 + R_2') = \underline{I_1^2 R_{01}}$ where $R_2' = \frac{R_2}{k^2}$

$\boxed{W_{cu} = I_1^2 R_{01}}$ where R_{01} is eqt. resist. of the transformer referred to primary.



$W_{cu} = I_1^2 R_1 + I_2^2 R_2 = I_2^2 R_1' + I_2^2 R_2$.

where $R_1' = R_1 k^2$. $W_{cu} = I_2^2 (R_1' + R_2)$

$\therefore \boxed{W_{cu} = I_2^2 R_{02}}$

R_{02} → eqt. resist. of the tr. referred to secondary.

ABES

DC Machines

Introduction

DC machines are electrical machines which convert one form of energy into another.

A dc machine which converts mechanical energy into electrical energy is called a dc generator.

A dc machine which converts electrical energy into mechanical energy is known as a dc motor. Both of them have the same construction. Therefore any dc machine can work either as a generator or a motor.

DC Generator

Principle of working

A dc generator works on the principle of Faraday's laws of electromagnetic induction.

Whenever a conductor is moved in a magnetic field and it cuts the flux, a dynamically induced emf is produced in it. Accdg. to Faraday's laws of EMI The magnitude of this induced emf in the conductor is given by $e = Blv \sin\theta$. where,

l = length of conductor in the magnetic field. (mt)

B = magnetic flux density in wb/m^2

v = velocity of the conductor (m/s)

θ = angle betn. the conductor & the direction of flux

The direction of this induced emf is given by Fleming's RH rule. This emf causes a curr. to flow in the conductor if the ckt. is closed.

Hence for a generating action to takes, the follg. are required:

(1) The conductor or coil.
② The flux. ③ The relative motion between the conductor and the flux.

In a practical generator, the conductors are rotated to cut the magnetic flux, keeping the flux stationary.
For obtaining a large voltage as the output, several conductors are joined together, to form a winding called the armature winding. of a dc machine. The armature winding is placed on the armature of a dc machine which is rotated by an external device called a prime mover. The prime movers can be steam engines, diesel engines or water turbines etc.

The magnetic flux is produced by the field poles, which are electromagnets carrying current in their field windings.

When the armature rotates in the magnetic field produced by the fieldpoles, an emf is induced in the armature winding.

Constructional features of a DC machine

Fig. shows the cross-sectional view of a 4 pole dc generator, showing various parts. The parts are:

1. Field system. — which is a stator.
2. Armature —. which is a rotor.
3. Commutator.
4. Brushes and brush-gear.
5. Bearings.

1 **Field system**. — The field system is used to create a uniform magnetic field in which the armature rotates

It consists of the following parts;

(1) Yoke. (2) poles with pole shoes and pole cores

(3) Field coils or field windings.

Yoke. *. Yoke forms the outer cover (or frame) for the DC machine and is cylindrical in shape. It has two functions

* (1) It provides mechanical support to the poles and protects the dc machine from harmful atmospheric conditions like moisture, dust, gases like SO_2 etc.

* 2. It offers a low reluctance path to the magnetic flux produced by the poles.

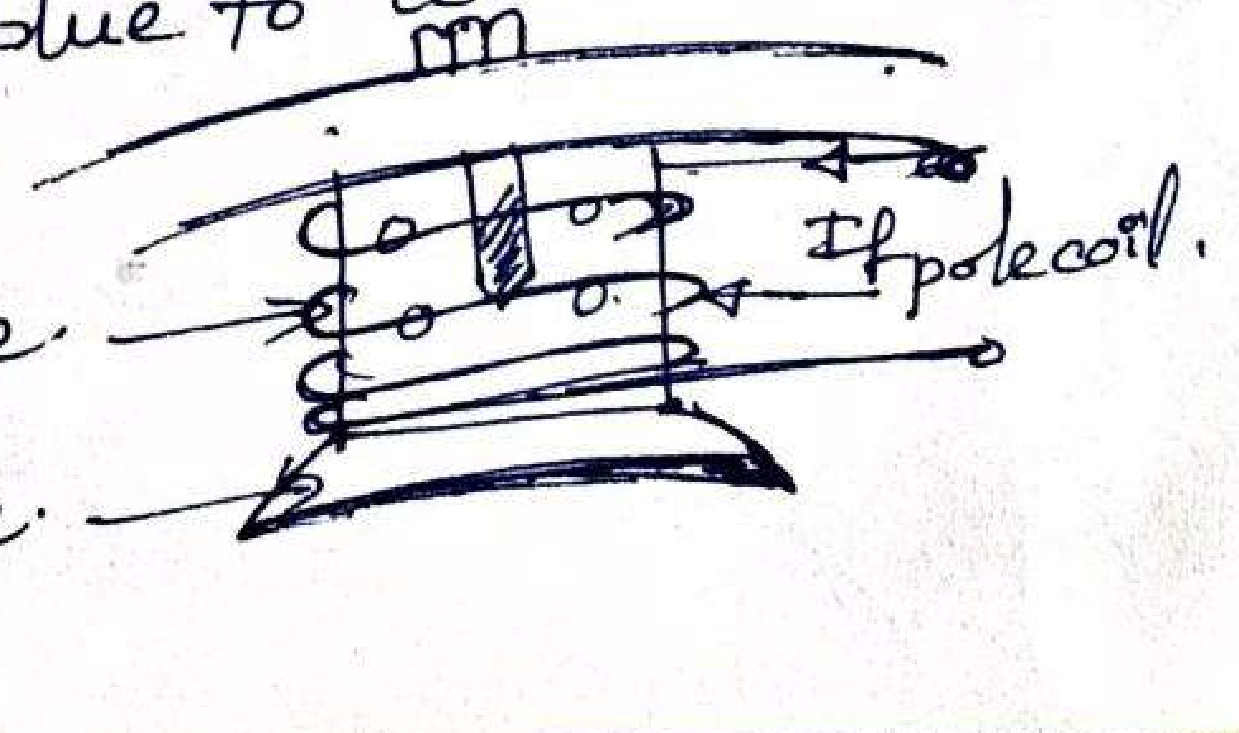
* Material used for yoke is cast iron for small machines and cast steel or silicon steel for large machines.

2. **Field poles** have the followg parts.

* **Pole cores:** They carry the field coils of insulated copper wire through which the field current flows. The core is of circular cross-section and are made of cast steel laminations which are rivetted together and bolted to the yoke.

* **pole shoes** – The pole shoes are also laminated, each lamination being insulated from one another, pressed together and riveted. The shape of the pole shoe is cylindrical at the bottom, so that the flux produced is spreadout uniformly in the airgap. Their functions are;

* They support the field coils.
* They spread out the flux in the airgap.
* They are of large cross-section, due to which the reluctance of the path is reduced.



* Field coils — These are coils of copper wire wound on the pole cores, which are also called exciting coils. They are used to magnetise the field poles, when d.c is passed through them. All the field coils are connected such that, the adjacent poles have opposite polarities when current flows through them.

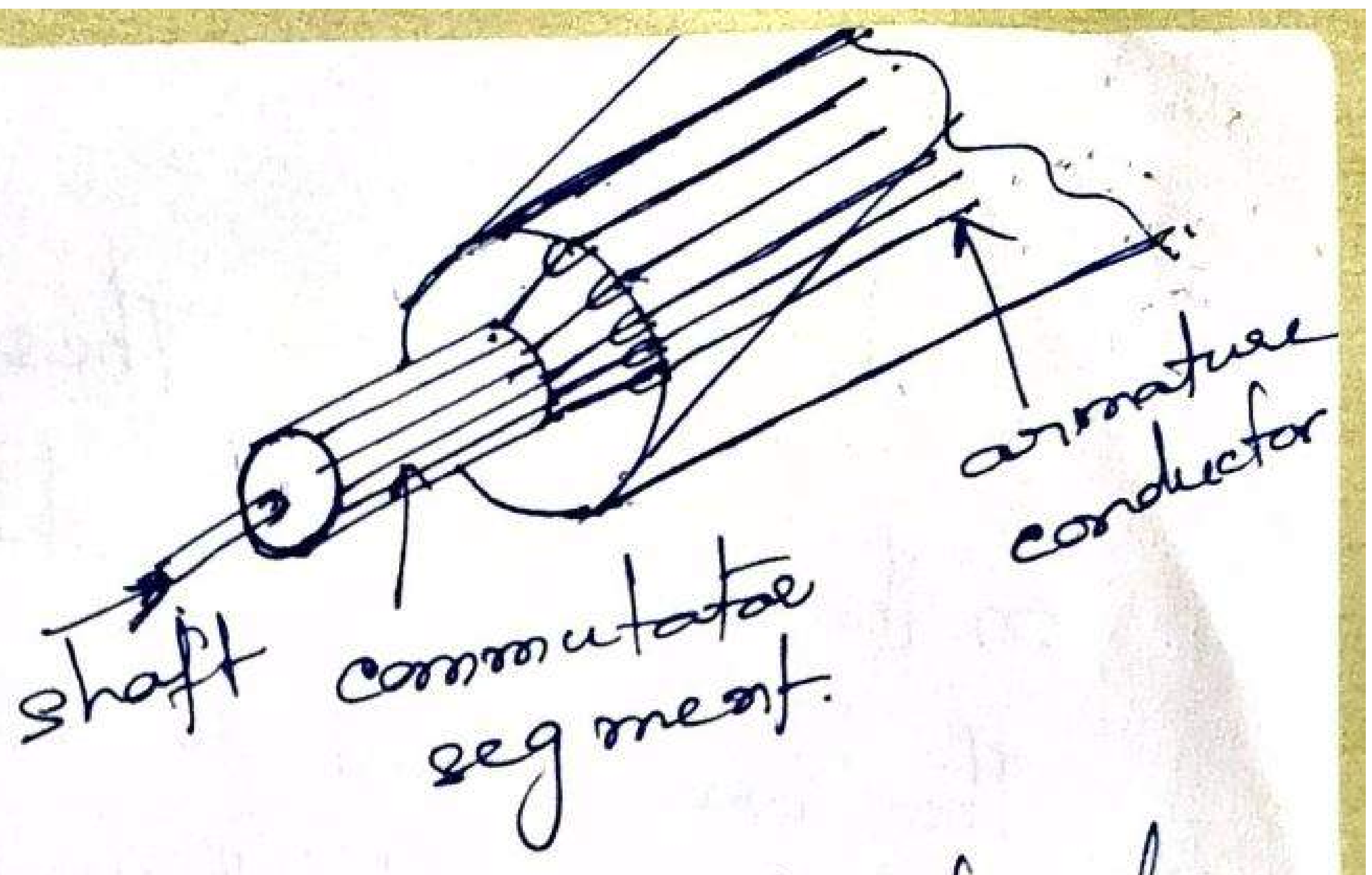
2. Armature - It has core and windings.

* Armature core - The armature core is made of high permeability laminations of silicon steel. These laminations are of 0.4 mm to 0.5 mm thickness and are insulated from one another by varnish. (The laminations are clamped between 2 flanges.) The outer periphery of the armature core has uniformly cut slots in which the armature conductors are placed. The conductors are insulated from the slot as well as from one another.

Axial ventilating ducts are provided on the core for cooling purpose. The core is laminated to reduce the eddy current losses and silicon steel is used to reduce the hysteresis losses. The functions of armature are:

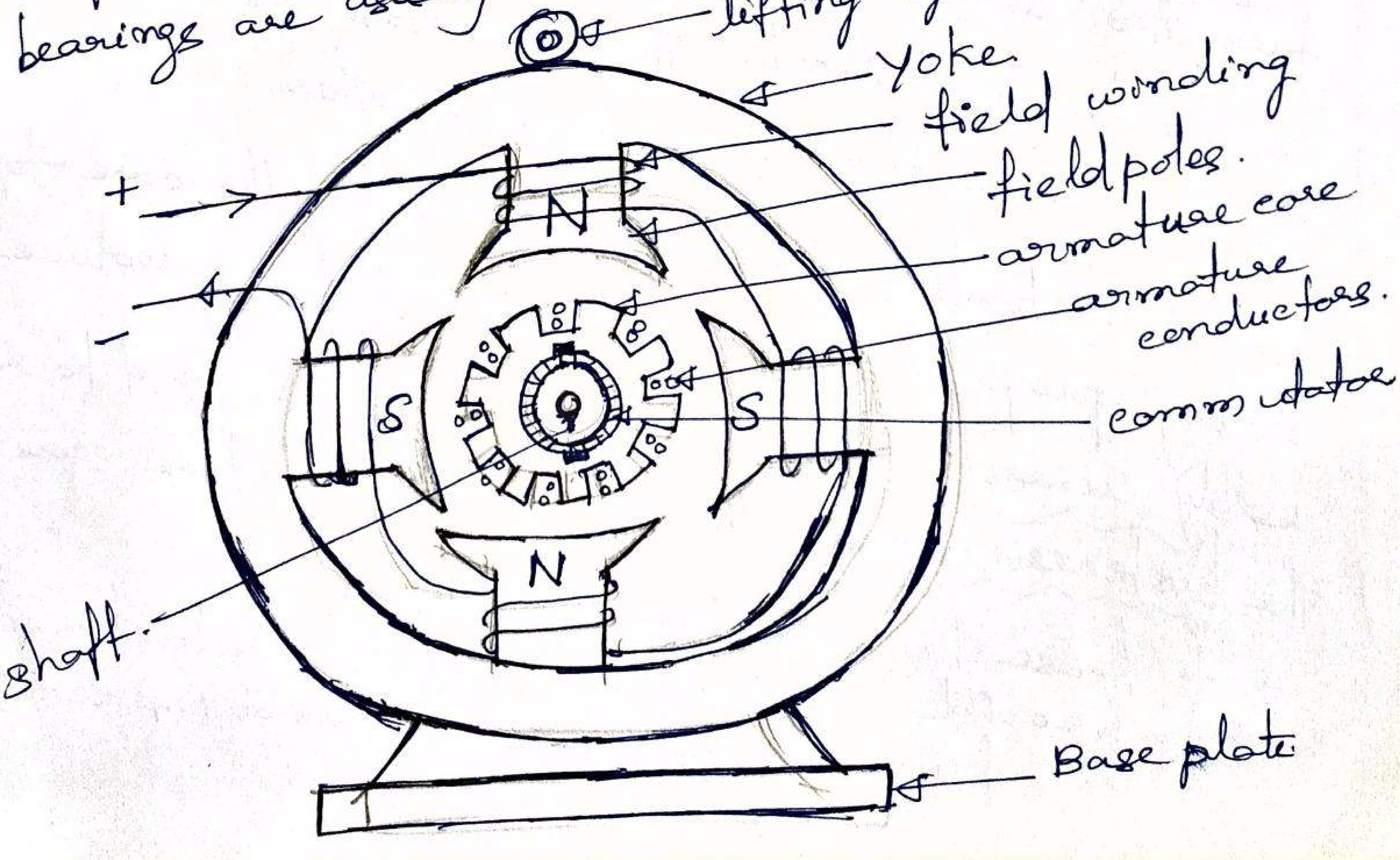
* to house the armature conductors.
* to provide a path of very low reluctance to the flux through the core from a N-pole to a S-pole

3 - Commutator



A commutator converts the alternating voltage generated in the rotating armature conductors into a unidirectional voltage. commutator is of cylindrical construction and is made up of wedge shaped copper segments. These segments are insulated from each other by thin layer of mica and the no. of segments is equal to the no. of armature coils.

4. **Brushes and bearings** - The function of brushes is to collect current from the commutator. They are rectangular blocks made of carbon and are housed in brush-holders. Ball bearings are usually used as they are more reliable.



Types of armature windings

There are 2 types: ① Lap winding ② wave windg.
according to the way in which the end connections of the conductors are connected to the commutator segments.

In lap winding, when the winding progresses, it appears as if one coil is lapping over the other coil.

In wave winding, when the windg. progresses, it progresses like a wave.

No. of parallel paths in a lap windg = no. of poles.

No. of parallel paths in a wave windg = 2.

Single layer winding - If there is only one coil side per slot of the armature, then windg. is called single layer winding.

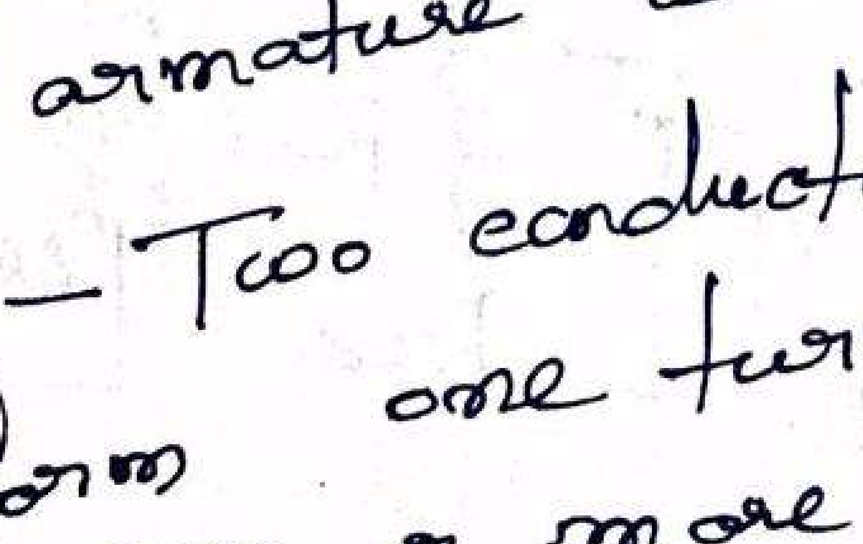
If there are 2 coil sides (conductors) in each slot of the armature, then the wdg is called a double layer wdg.

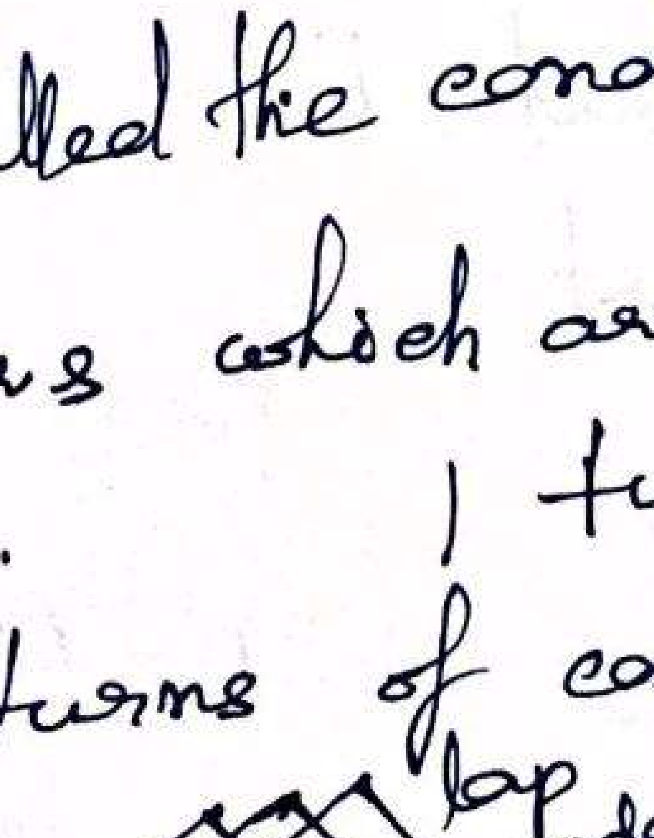
Conductor ; Each individual wire lying in the slots of an armature is called the conductor, (where emf is induced)

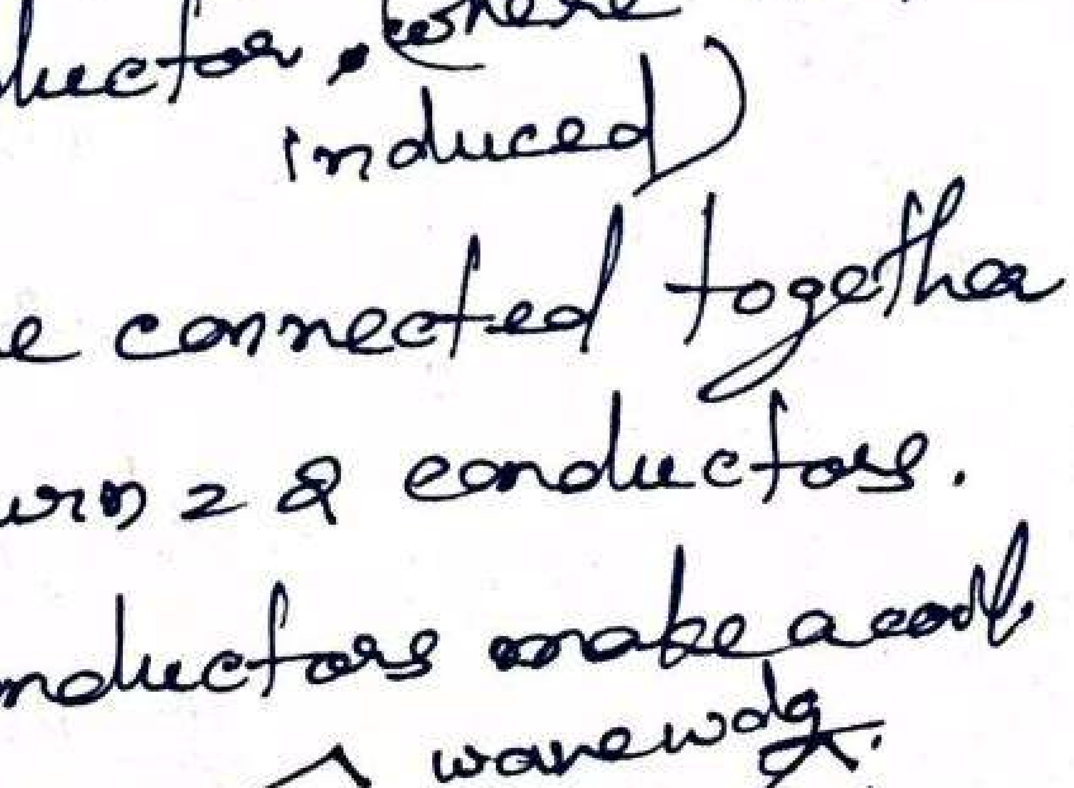
Turn. - Two conductors which are connected together form one turn. 1 turn = 2 conductors.

Coil - One or more turns of conductors make a coil.

Turn.







Types of DC Generators

Depending on the nature of excitation provided to the field windings, DC generators are broadly classified as, ⓐ separately excited dc gentr. & (b) self excited dc generator.

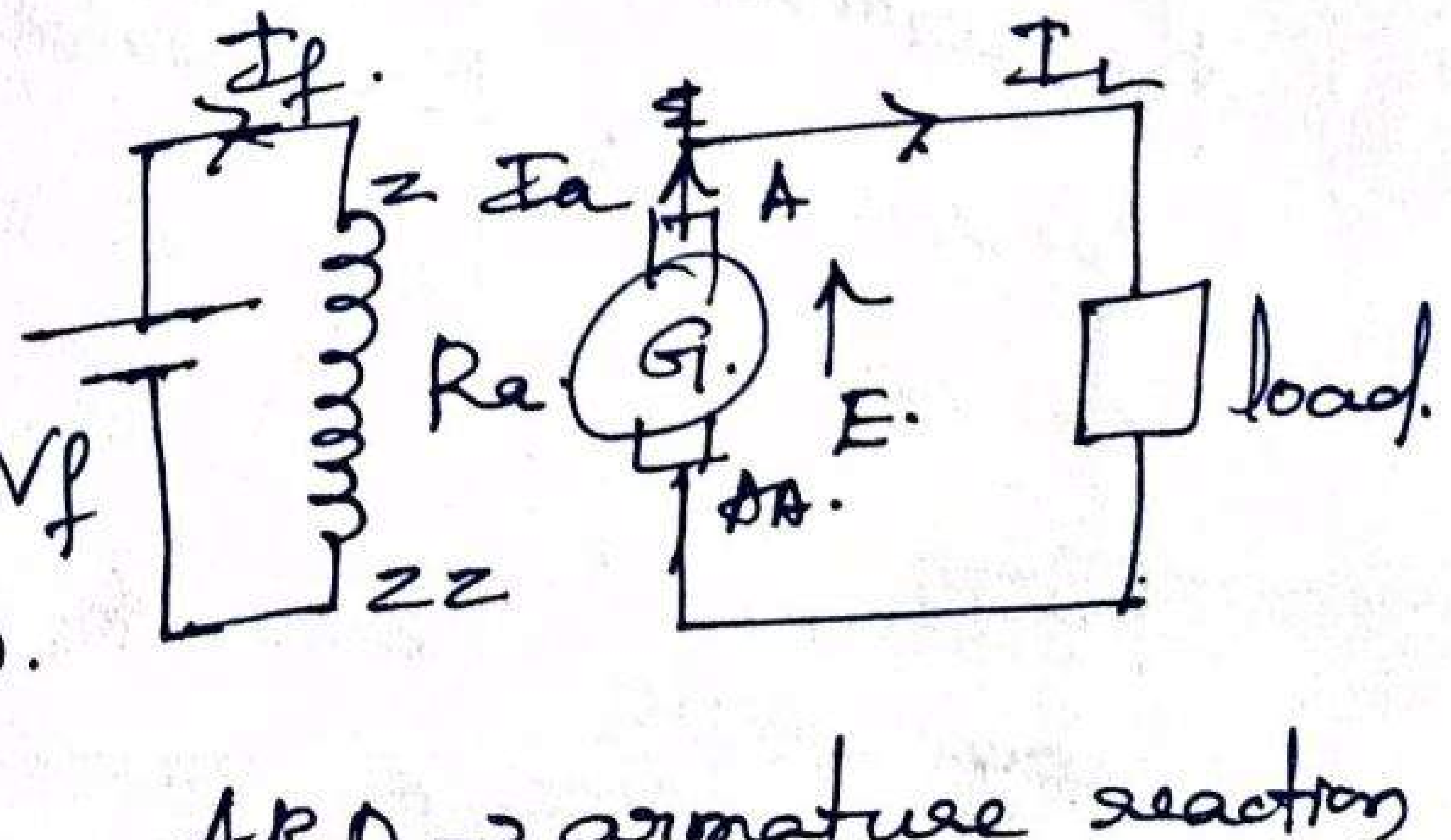
ⓐ Separately excited generator

In this type, the excitation (field current) to the field wdg. is provided by a separate DC source of voltage V_f. This source drives a currt. I_f through the field wdg. due to which, magnetic flux is produced. when the armature is rotated, the armature conductors cut the magnetic flux and hence an emf E is induced, which is the generated voltage. when the load (resist) is connected across the armature terminals, a currt I_L flows through the load.

From fig,

the armature currt $I_a = I_L$.

$I_L \rightarrow$ load currt.



Terminal voltage

$V = E - I_a R_a - BCD - ARD$.

$BCD \rightarrow$ brush contact drop. $ARD \rightarrow$ armature reaction drop.

Power developed by the armature $P = E I_a$ watts.

(ii) Self excited generators.

In this type, the field coils are excited by the curnt supplied from the voltage generated by the generator itself.

working:

[Due to residual magnetism, some flux is always present in the poles. when the armature is rotated the armature conductors cut the residual flux, due to which a small emf is induced in the generator. The emf sends a small curnt. through the field wdg. This curnt increases the flux, which in turn increases the induced emf further, till it reaches the rated output voltage. Hence the generator attains its normal field strength.]

Self excited generators may be classified into:

① Series - wound generator.

② Shunt generator ③ Compound generator.

① Series - wound generator

In series generators, the field coil is connected in series with the armature conductors.

As they carry full load curnt., these field coils consist of a few turns of thick wire having low resistance.

3. Compound generator

A dc compound gentr. contains both series field and shunt field windings. There are mainly 2 types.

ⓐ. Cumulative compound generator – If the two field windings are connected in such a way that the fluxes produced by them are in the same direction and are additive, then the gentr. is said to be cumulatively compounded.

ⓑ Differential compound generator — If the two field windings are connected in such a way that the 2 fluxes produced by them are in opposite direction and the resultant flux is the difference between the two, then the gentr. is said to be differentially compounded.

Depending on how the series ~~and~~ field winding is connected to the shunt field wdg., there are long shunt and short shunt compound gentrs.

ⓐ Cumulative compound generator

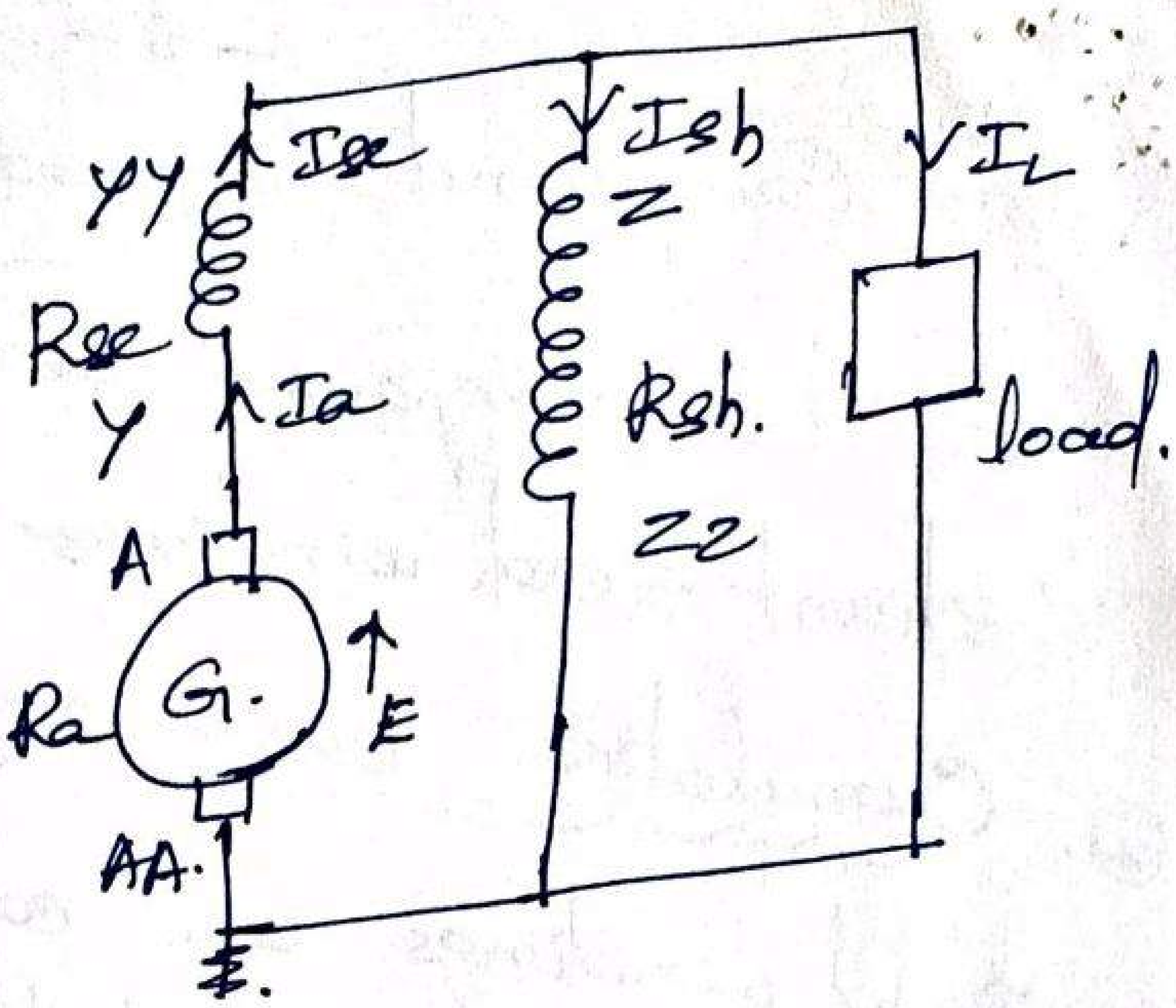
①. Long shunt cumulative compd gentr

Total flux, $\phi = \phi_{sh} + \phi_{se}$. where $\phi_{sh} \to$ shunt field flux

$\phi_{se} \to$ series field flux

$I_a = I_{se}$.

① $I_{sh} = \frac{V}{R_{sh}}$.



② $I_a = I_L + I_{sh}$.

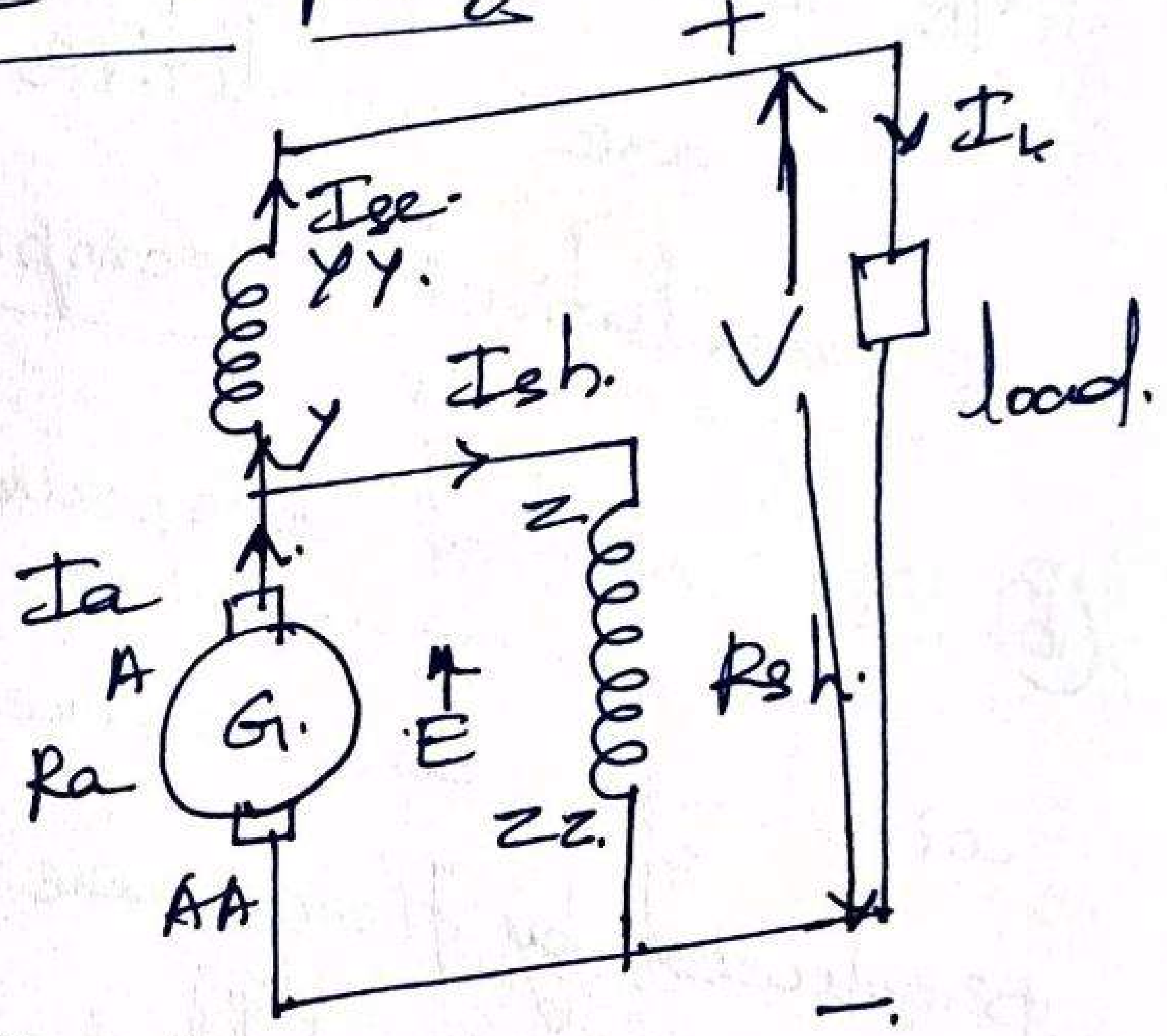
③ Terminal voltage,

(3) $V = E - I_a (R_a + R_{se})$

— B.C.D — A.R.D

④ $P = E I_a$.

② short shunt cumulative compd. gentr.



① $I_{se} = I_L$

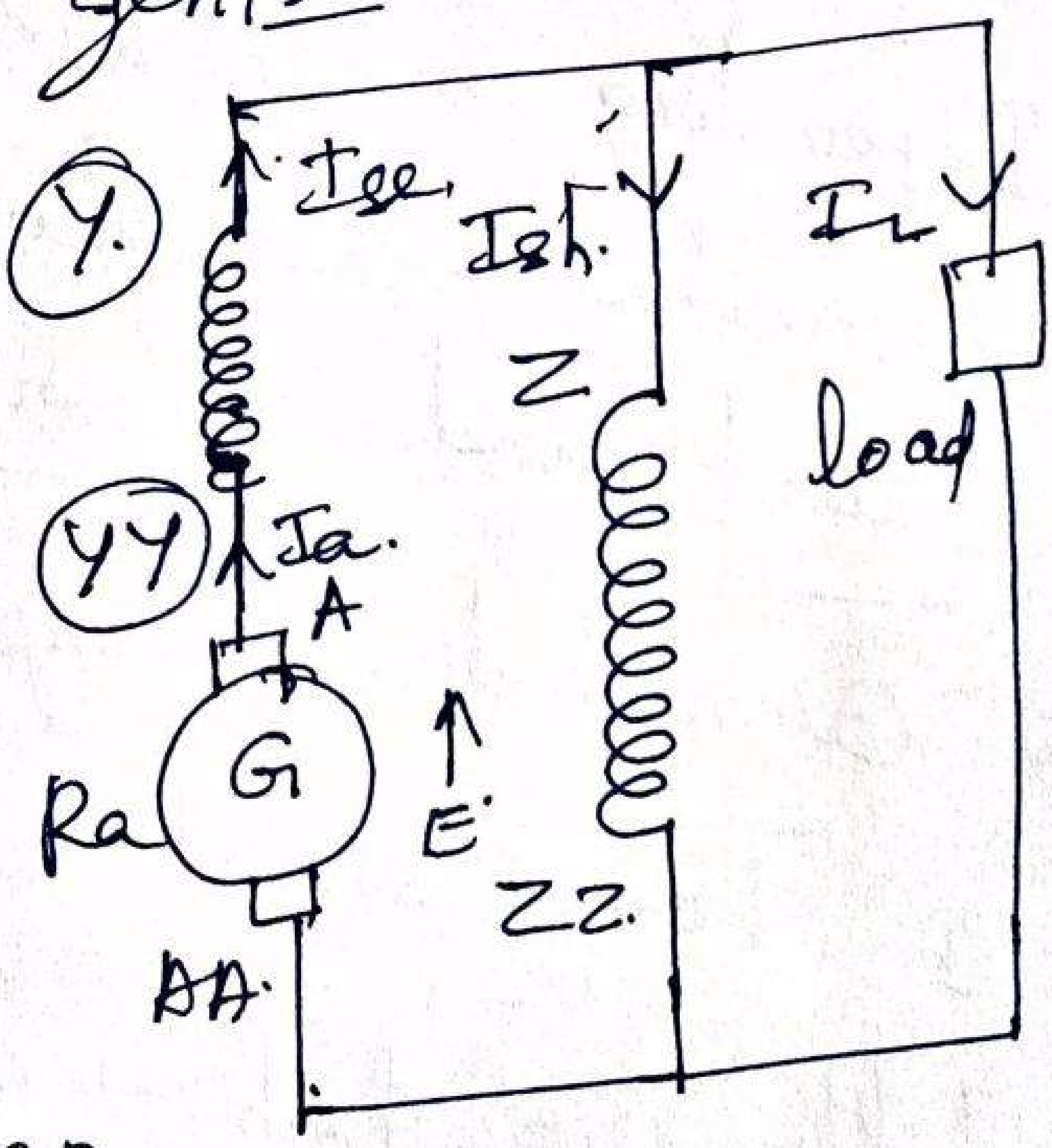
② $I_{sh} = \frac{V + I_{se} R_{se}}{R_{sh}}$.

③ Terminal voltage

$V = E - I_a R_a - I_{se} R_{se}$.

— BCD — ARD.

⑤ Differential compound gentr.



The resultant flux

$\phi = \phi_{sh} - \phi_{se}$

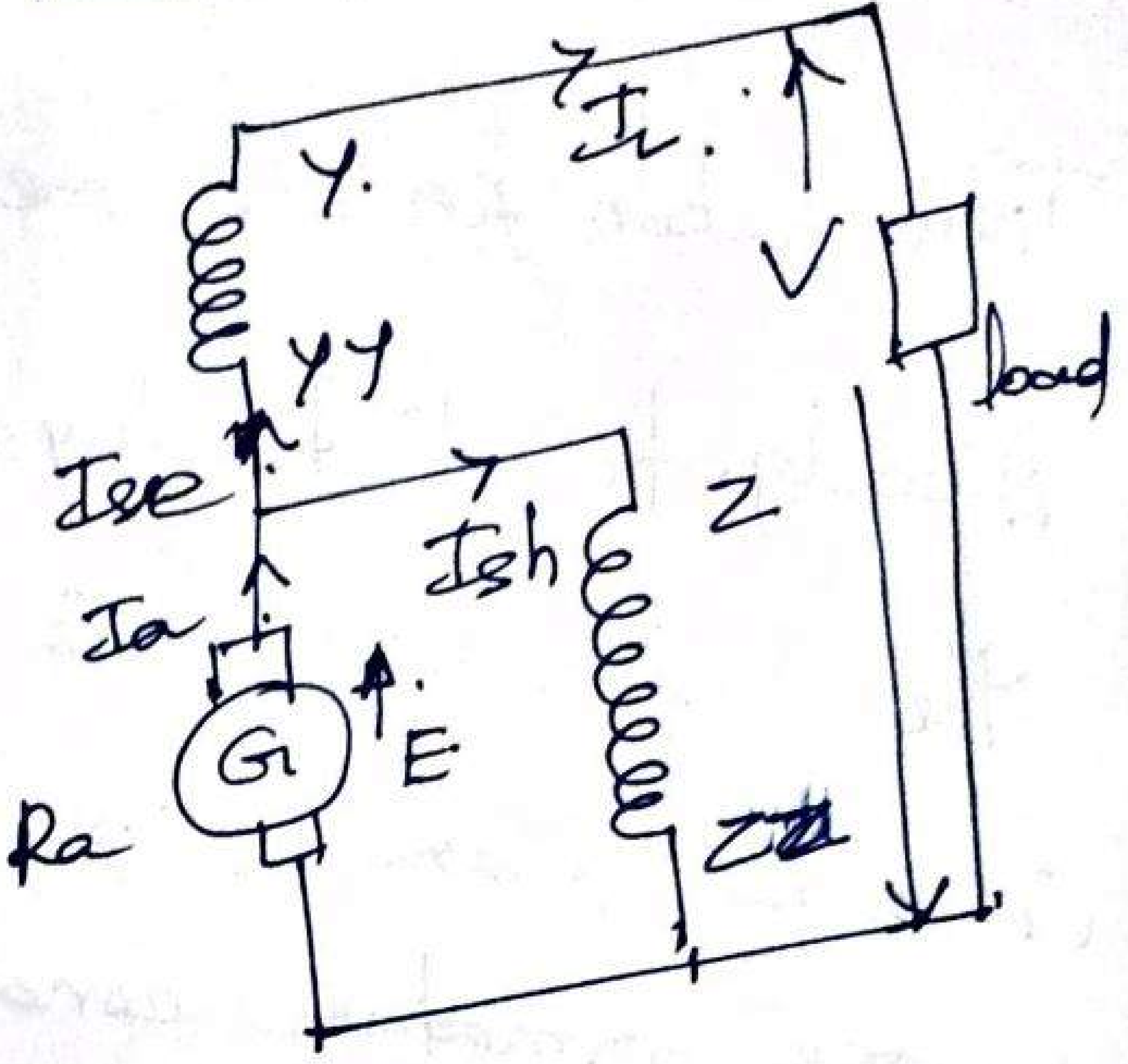
$I_{sh} = \frac{V}{R_{sh}}$.

$I_a = I_L + I_{sh}$.

$V = E - I_a (R_a + R_{se})$ — ARD

— BCD.

② Short shunt differential compound motor



$\phi = \phi_{sh} - \phi_{se}$.

$I_a = I_{se} + I_{sh}$.

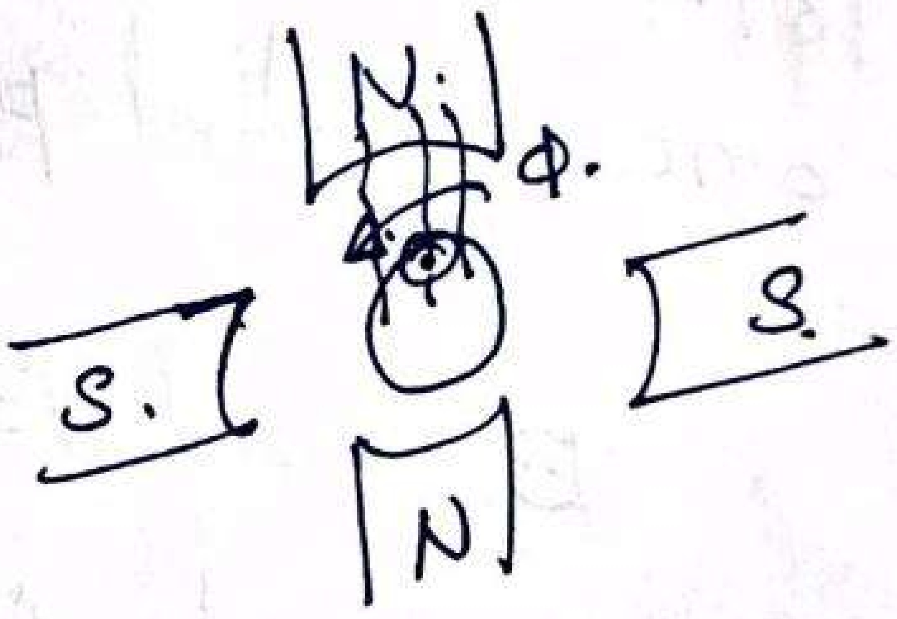
$I_a = I_L + I_{sh}$

$I_{se} = I_L$

$$I_{sh} = \frac{V + I_L R_{se}}{R_{sh}}.$$

$V = E - I_a R_a - I_L R_{se} - BCD - ARD$

E.m.f equation of DC Generator



Consider a dc generator with

ϕ → useful flux / pole in wb.

P → total no. of poles.

Z → total no. of armature conductors.

A → no. of parallel paths.

N → speed of rotation of armature in r.p.m.

E → emf generated in any of the parallel paths

A = P for lap wound (generator) armature wdg.

A = 2 for wave wound armature. wdg.

Consider one armature conductor making one revolution.

The flux cut by one conductor in one revolution

$$d\phi = P\phi \text{ wbs.}$$

Time taken for one revolution of armature $\cdot$ $dt = \frac{60}{N}$ sec

Accdg. to Faraday's laws of electromagnetic induction, the emf induced is equal to the rate of change of flux.

∴ Emf generated in one armature conductor $\Big\} = 1 \cdot \frac{d\phi}{dt} = \frac{P\phi}{\frac{60}{N}}$

$$= \frac{NP\phi}{60} \text{ volts}$$

No. of conductors in each parallel path $= \frac{Z}{A}$

∴ Total emf induced in one parallel path = Total emf generated in the generator

E = (Voltage generated in one conductor) × (no. of conductors in one parallel path)

$$E = \frac{NP\phi}{60} \times \frac{Z}{A} = \frac{\phi ZNP}{60A} \text{ volts.}$$

$$\therefore \boxed{E = \frac{\phi ZNP}{60A}}$$

A = 2 for wave winding ∴ $E = \frac{\phi ZNP}{120}$ volts

A = P for lap winding ∴ $E = \underline{\underline{\frac{\phi ZN}{60}}}$ volts.

jan'14.

① An $\overset{(4)}{8}$ pole generator has $\overset{(1000)}{500}$ armature conductors and has a useful flux/pole of $\overset{0.052}{0.065}$ wb. what will be the emf generated if it is lap connected and runs at 1000 rpm? what must be the speed at which it is to be driven to produce the same emf if it is wave wound? (800).

(1) Given
P = 8. Z = 500 ϕ = 0.065 wb E = ?
lap. N = 1000 rpm. N_2 = ? → wave?

(1) when lap connected

$$E = \frac{\phi Z N P}{60 A} = \frac{0.065 \times 500 \times 1000 \times 8}{60 \times 8} = 541.67V$$

(2) when wave connected

A = 2.

$$E = \frac{\phi Z N P}{60 A}$$

$$541.67 = \frac{0.065 \times 500 \times \quad 1000 \times 8 \quad N}{60 \times 2}$$

N = 250 rpm

July'18.

②. The emf generated in the armature of a shunt genrt. is 625 volts, when delivering its full load current of 400A to the external ckt. The field curnt is 6A and the arm. resist is 0.06Ω. what is the Terminal voltage?

$I_a = 400 + 6 = 406\,A$

$V = E_g - I_a R_a = 625 - 406 \times 0.06 = 620.64V$

Jun12.
(Ans)

3) An 8 pole, lap connected armature has 40 slots with 12 condrs/slot., generates a voltage of 500V. Determn. the speed at which it is running if the flux per pole is 50 mwb.

P = 8. A = P. S = 40. 12 conds/slot

E = 500V $\phi = 50$ mwb.

$$E = \frac{\phi Z N P}{60 A}$$

= Total no. of Conductors = no. of slots × no. of conductors/slot.

= 12×40

$$E = 500 = \frac{50 \times 10^{-3} \times 12 \times 40 \times 8 \times N}{60 \times 8}$$

N = 1250 rpm

11, Jan09)
HW.

4) A 4 pole, 1500 rpm dc gentr. has a lap wound armature having 24 slots with 10 conductors/slot. If the flux/pole is 0.04wb, calculate the emf generated in the armature. what would be the generated emf if the windg is wave connected? (6m)

Given: A = P P = 4, N = 1500 rpm. Z = 24×10. $\phi = 0.04$wb.

Lap connected $E = \frac{\phi Z N P}{60 A} = \frac{0.04 \times 24 \times 10 \times 1500 \times 4}{60 \times 4} = 240V$

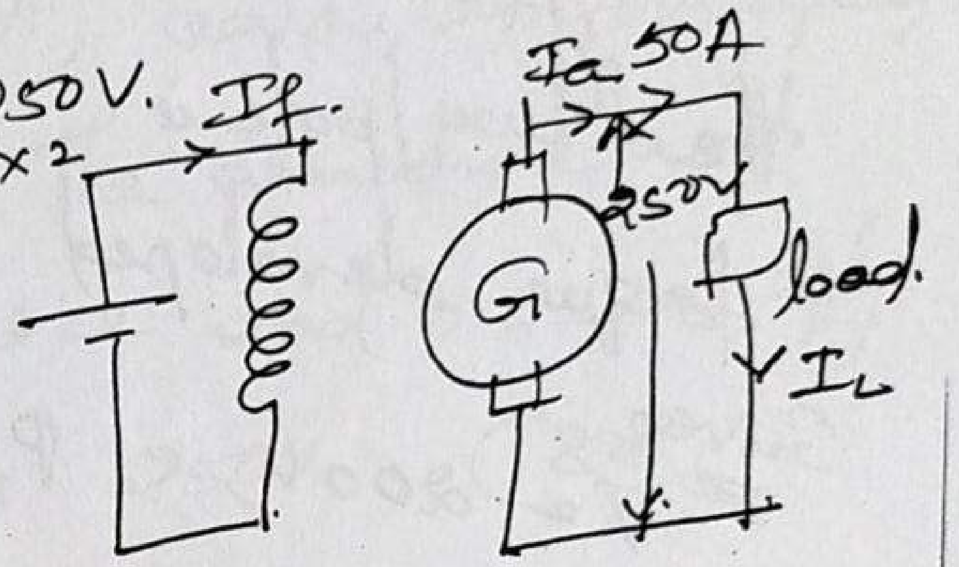
wave windg. $E = \frac{0.04 \times 24 \times 10 \times 1500 \times 4}{60 \times 2} = 480V$

(3) **Jones** (5m)

A separately excited DC Generator when running at 1000 rpm supplies 50A at 250V. Find how much current it will deliver when the speed falls to 800 rpm. Take armature resist as 0.01 Ω and brush drop of 1V/brush.

Given $N_1 = 1000$ rpm $I_a = 50A$. $V = 250V$.

$N_2 = 800$ rpm $I_{a2} = ?$ $Ra = 0.1 \Omega$. $BCD = 1 \times 2$



$Eg_1 = V + Ia_1 Ra + BCD.$

$Eg_1 = 250 + (50 \times 0.01) + 2 \times 1$

① $Eg_1 = \underline{252.5 \text{ V.}}$

② $\underline{Eg_2}$

$$\frac{Eg_2}{Eg_1} = \frac{N_2}{N_1}.$$

$$\frac{Eg_2}{252.5} = \frac{800}{1000}.$$

$Eg_2 = \underline{202V}$

③ Load resistance $R_L = \frac{V}{I_L (= I_a)} = \frac{250}{50}$

$R_L = \underline{5 \Omega}$

$V_2 = I_{a2} R_L = 5 I_{a2}. = 5 I_L$

$Eg_2 = V_2 + I_{a2} Ra + 2 \times 1. = 5 I_{a2} + ~~0~~$

$202. = 5 I_{a2} + 0.1 I_{a2} + 2$ | $5 I_{a2} = 200.$

$I_{a2} = \frac{200}{5.01} = \underline{39.92 A}$

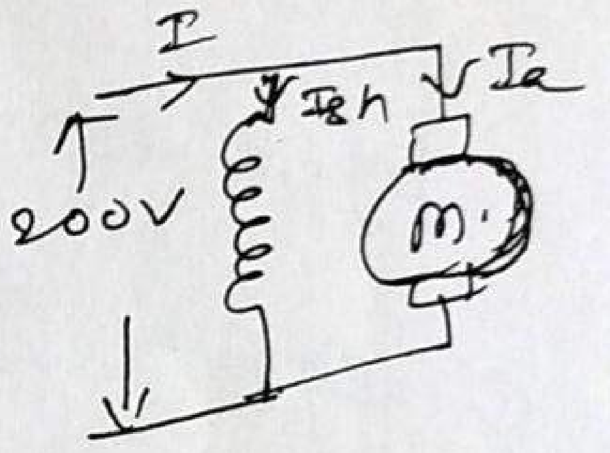
Jan10 -

w ⑥: A 200V., 4 pole lap wound, dc shunt motor has 800 conductors on its armature. The resist of the arm. windg is 0.5 Ω and that of shunt field windg is 200Ω. The motor takes a curnt of 21A, the flux/pole is 30 mwb. Find the speed and gross torque developed in the motor

Given

$V = 200V$, $P = 4$ $A = P$. $Z = 800$. $R_a = 0.5\Omega$

$R_{sh} = 200\Omega$. $I = 21A$. $\phi = 30$ mwb. $N = ?$ $T_a = ?$



Soln

$$I_{sh} = \frac{V}{R_{sh}} = \frac{200}{200} = 1.A$$

$$I_a = I - I_{sh} = 21 - 1 = 20A.$$

$$E_b = V - I_a R_a = 200 - 20 \times 0.5 = \underline{\underline{190V}}$$

$$E_b = \frac{\phi Z N P}{60A}. \quad \therefore N = \frac{E_b \times 60A}{\phi Z P}.$$

① $$N = \frac{190 \times 60 \times 4}{30 \times 10^{-3} \times 800 \times 4} = \underline{\underline{475 \text{ rpm}}}$$

② $$T_a = 0.159\, \phi \frac{Z I_a P}{A}.$$

$$= 0.159 \times 30 \times 10^{-3} \times 800 \times 20 \times 4/4 = \underline{\underline{76.32 Nm}}$$

Jul!!, 7m)

⑦ A 4 pole DC shunt motor takes 22A from 220V supply. The armature and field resists are resply 0.5Ω and 100Ω. The armature is lap connected with 800 conductors. If the flux/pole = 20mwb, calculate the speed & gross torque

(~~525~~.25 rpm, 18.9Nm)

2101.

DC Motors -8-.

Motor Principle

An electric motor is a machine which converts electric energy into mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left hand Rule and whose magnitude is given by, $F = Bil$ Newton.

where, F → force experienced in Newtons

B → flux density of the magnetic field in wb/m^2.

I ⇒ current flowing through the conductor in Amps

l → length of the conductor in mts.

Constructionally, there is no basic difference between a dc generator and a dc motor. Hence, a dc motor can be used as a generator and vice-versa.

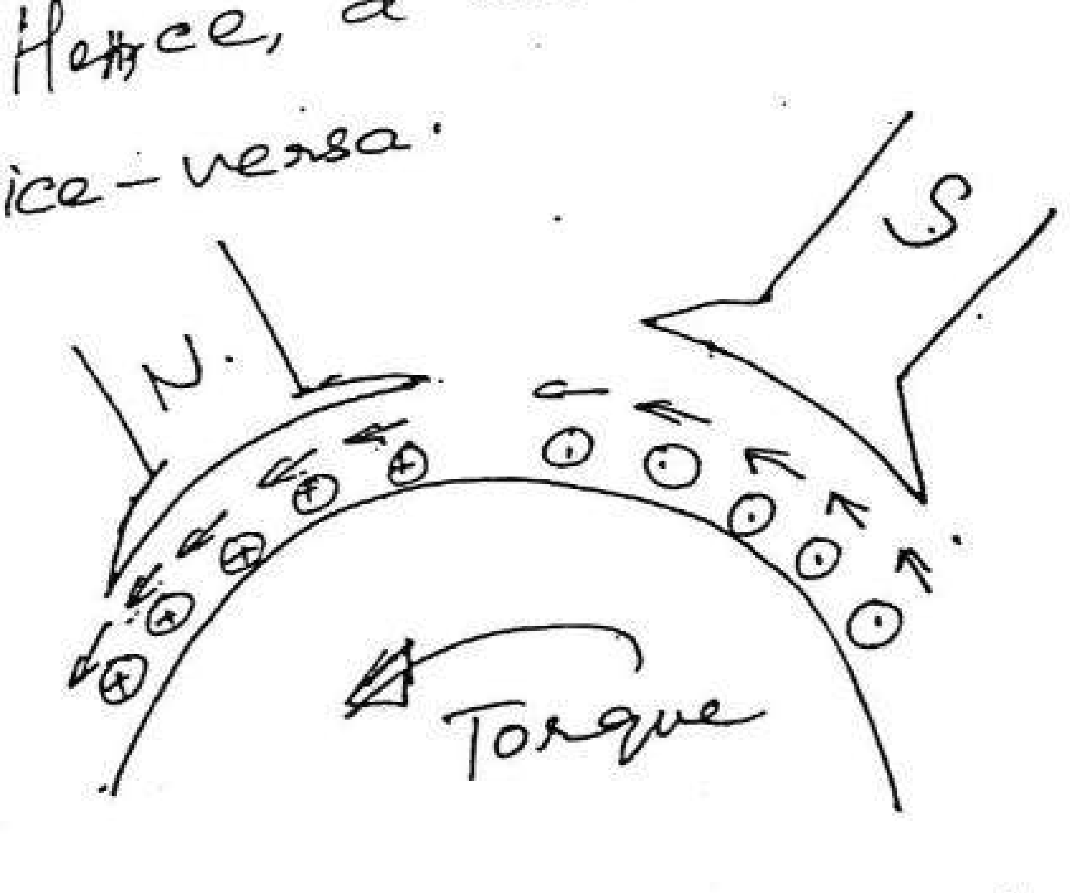
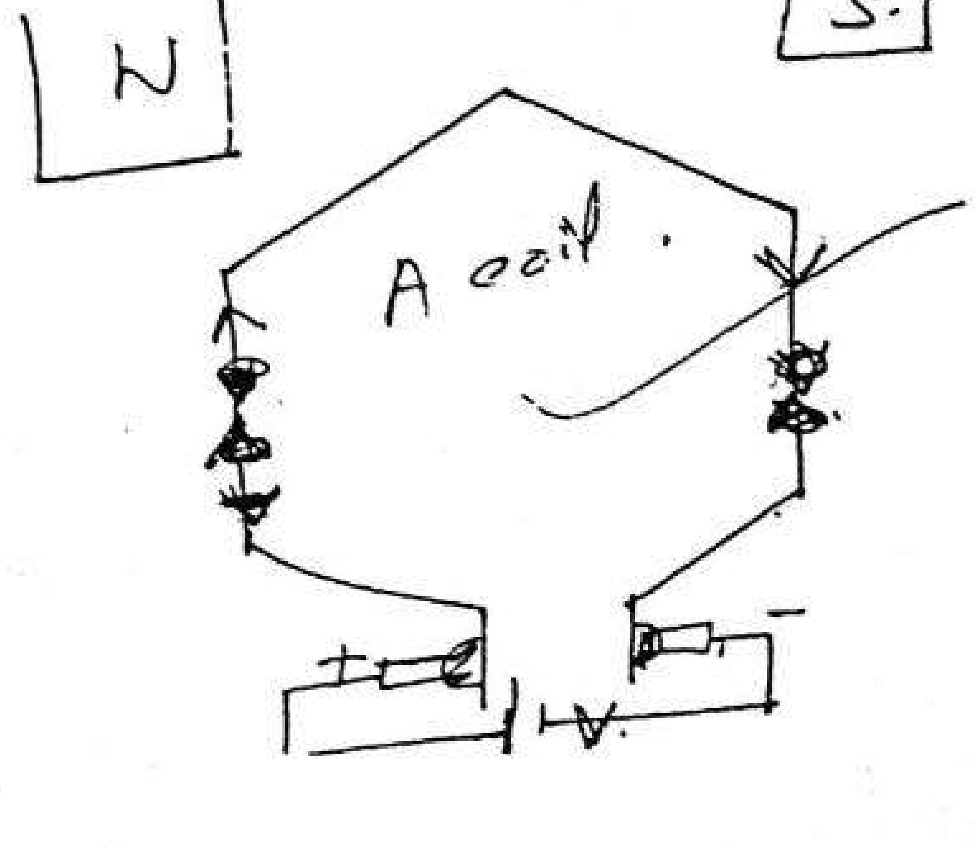


Fig shows a part of a motor. when its field magnets are excited and its armature conductors are supplied with current from the supply mains, they experience a force tending to rotate the armature.



Armature conductors under N-pole are ~~a~~ carry the currents downwards(+) and those under S-poles carry the current upwards (shown by dots). The direction of the force on each conductor can be found which is shown small arrows placed above each conductor. It is seen that each conductor experiences a force F which tends to rota the armature in anticlockwise direction. These forces collecti collectively produce a driving torque which sets the armature rotation.

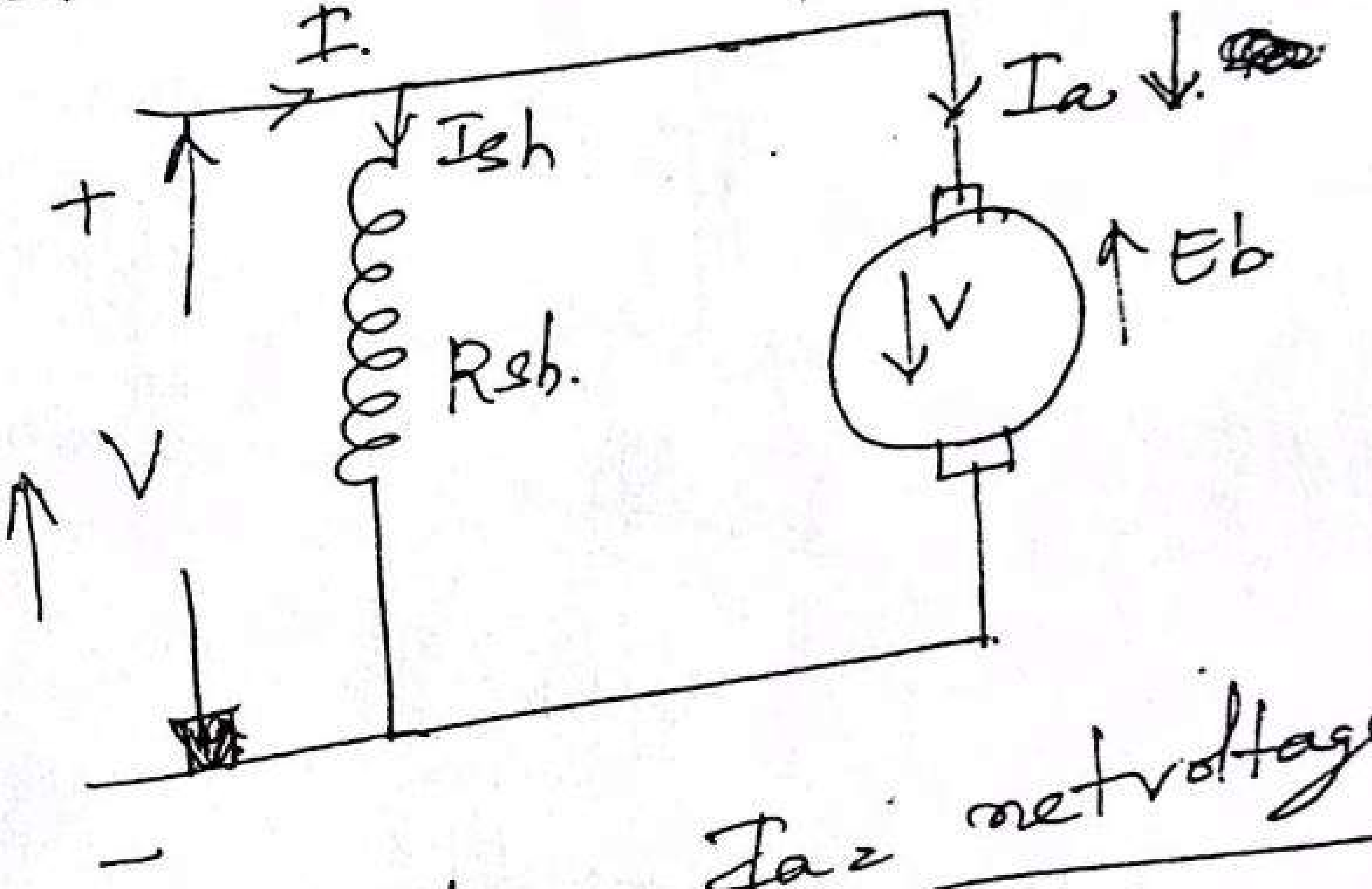
The function of a commutator in the motor is the same as in a genta By reversing current in each conductor as it passes from one pole to another, it helps to develop a continuous and unidirectional torque.

Back Emf (Eb)

When a motor is connected to the supply, the armature current I_a flows through its armature conductors and in the presence of ~~field~~ magnetic field produced by the field poles, a torque is produced and the armature rotates. As soon as the armature starts rotating, (accdg to laws of e.m indu) a dynamically induced emf is produced in the armature condrs due to the cutting of flux by the arms. conductors. The direction of this induced emf is such as to oppose the applied voltage and hence it is called as the back emf (Eb got by applying Fleming's RH Rule) Its value is the same as the motionally induced emf in the generator.

i.e $E_b = \frac{\phi Z N P}{60 A}$ volts.

The applied voltage V has to force current through the armature conductors against this back emf Eb. The electric work done in overcoming this opposition is converted into mechanical energy developed in the armature. Fig shows the motor equivalent ckt with Eb, V and armature current Ia.



The back emf is always less than the applied voltage and

The net voltage across the armature ckt = $V - E_b$ $I_a = \frac{\text{net voltage}}{\text{Resistance}}$

$$\boxed{\therefore I_a = \frac{V - E_b}{R_a}}$$

Significance of Back Emf

[Due to the presence of back emf, the dc motor becomes a self-regulating machine.] i.e the motor is made to draw armature current, which is just required for developing the ~~st~~ torque required by the load.

W.K.T. $I_a = \frac{V - E_b}{R_a}$.

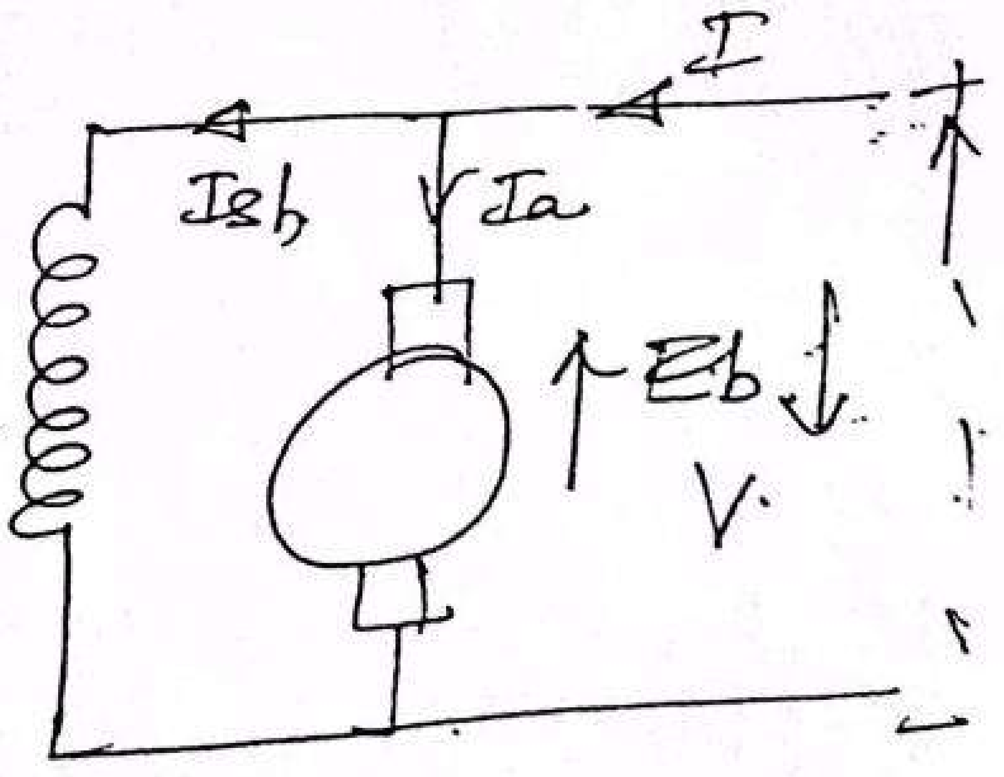
1) If load on the motor is suddenly increased, it will result in the slowing down (or reduction in speed) the motor. This will reduce the back emf, since $E_b \propto N$. with the decreased back emf (E_b), the current dra by the motor ↑ses accdg to the above eqn for I_a

The increase in current increases the driving torque or armature torque. Thus, the driving torque ↑ses with the increased load and avoids stopping of the motor motor.

Similarly, if the load on the motor is ~~a~~ decreased, the speed ↑ses E_b ↑ses and hence I_a ↓ses. This decrease in I_a reduces the driving torque of the motor to the point where it is just sufficient drive the decreased load.

Thus, the current drawn from the supply is automatically controlled by the back emf. such that it is just sufficient to drive the required load.

Voltage Equation of a motor



The applied voltage V has to supply

- * I_aR_a drop in the armature
- * Back emf E_b
- * Brush contact drop.

ie $V = E_b + I_aR_a + B \cdot C \cdot D \cdot$ ①.

This is called the voltage equation of a dc motor.

where, E_b is the back emf, given by

$$E_b = \frac{\phi Z N P}{60 A}$$

Multiplying equation ① by I_a and neglecting B·C·D,

$VI_a = E_bI_a + I_a^2 R_a$. This is the power equation of a motor.

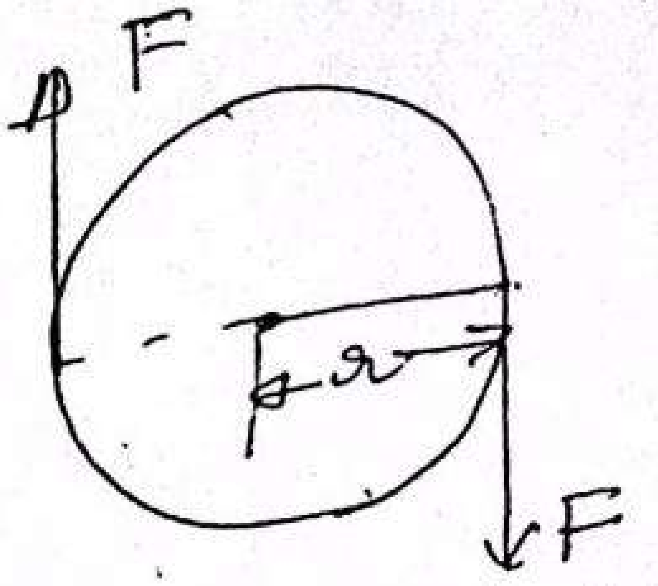
where,

VI_a → Electrical power input to the armature.

$I_a^2 R_a$ → Copper loss in the armature.

E_bI_a → Electrical equivalent of the mechanical power developed by the armature, which includes iron losses and mechanical losses.

Torque equation of a motor.



Torque is the turning moment about an axis. It is equal to the product of the force and the radius at which it acts.

Consider the armature of the DC motor with a radius r. and a force F acting tangential to its surface as show in fig.

The ~~torque~~ torque exerted by this force F is given by,

$$T = (F \times r) \text{ N-mt.}$$

The workdone by this force F in one revolution. } $= F \times 2\pi r$ wst

$= ($ Force x distance covered in one rev

The power developed by the armature — } = workdone in one second.

$=$ workdone in one revolution X no. of revolutions per sec

$$= \cancel{2}(F \times 2\pi r)\left(\frac{N}{60}\right).$$

$$= (F \times r)\left(\frac{2\pi N}{60}\right)$$

$$= (T_a)\left(\frac{2\pi N}{60}\right)$$

Power developed $= \dfrac{2\pi N T_a}{60}$ watts

We know that the electrical equivalent of this mechanical power developed by the motor armature is equal to E_bI_a.

$$\therefore \quad E_bI_a = \frac{2\pi N T_a}{60}$$

But, $E_b = \frac{\phi Z N P}{60A}$

$$\therefore \quad T_a = \frac{E_b I_a}{\left(\frac{2\pi N}{60}\right)}$$

$$\therefore \quad T_a = \frac{\frac{\phi Z \cancel{N} P}{\cancel{60}A} I_a}{\frac{2\pi \cancel{N}}{\cancel{60}}} = \frac{1}{2\pi}\left(\frac{\phi Z P I_a}{A}\right)$$

$$T_a = 0.159 \frac{\phi Z P}{A} I_a \quad \text{Nmt} \quad — ①$$

$$T_a = 0.0163 \frac{\phi Z P}{A} I_a \quad \text{kg mt} \quad — ②$$

The equations ① & ② give the torque developed by the armature Ta. This is the gross torque which includes iron losses and mechanical (friction and windage) losses of the motor.

Shaft Torque

The torque available at the shaft (ie o/p) of the motor to do some useful work is known as shaft torque. This torque is also called useful torque and is represented by Tsh. The shaft torque available at the shaft of the motor is always less than the developed torque (ie armature torque). This is because, there will be some torque lost due to friction and windage losses and the iron losses. This lost torque is given by TL.

Then, $T_{sh} = T_a - T_L$ T_{sh} - shaft torque

T_a = armature torque.

T_L = lost torque.

∴ The o/p of the motor is given by,

$$o/p \text{ in watts} = \frac{2\pi N T_{sh}}{60}.$$

$$\therefore T_{sh} = \frac{o/p \text{ in watts}}{\left(\frac{2\pi N}{60}\right)} \text{ Nmt}.$$

If the o/p is expressed in HP

$$T_{sh} = \frac{o/p \text{ in HP} \times 735.5}{\left(\frac{2\pi N}{60}\right)} \text{ Nmt}$$

Also, $T_a = \frac{E_b I_a}{\frac{2\pi N}{60}}$.

Types of DC motors.

According to the way in which the fieldwindgs. of the motor are connected to the armature, dc motors are mainly of 3 types:

(1.) DC shunt motor ②. DC series motor.

③ DC compound motor.

(1) DC Shunt Motor

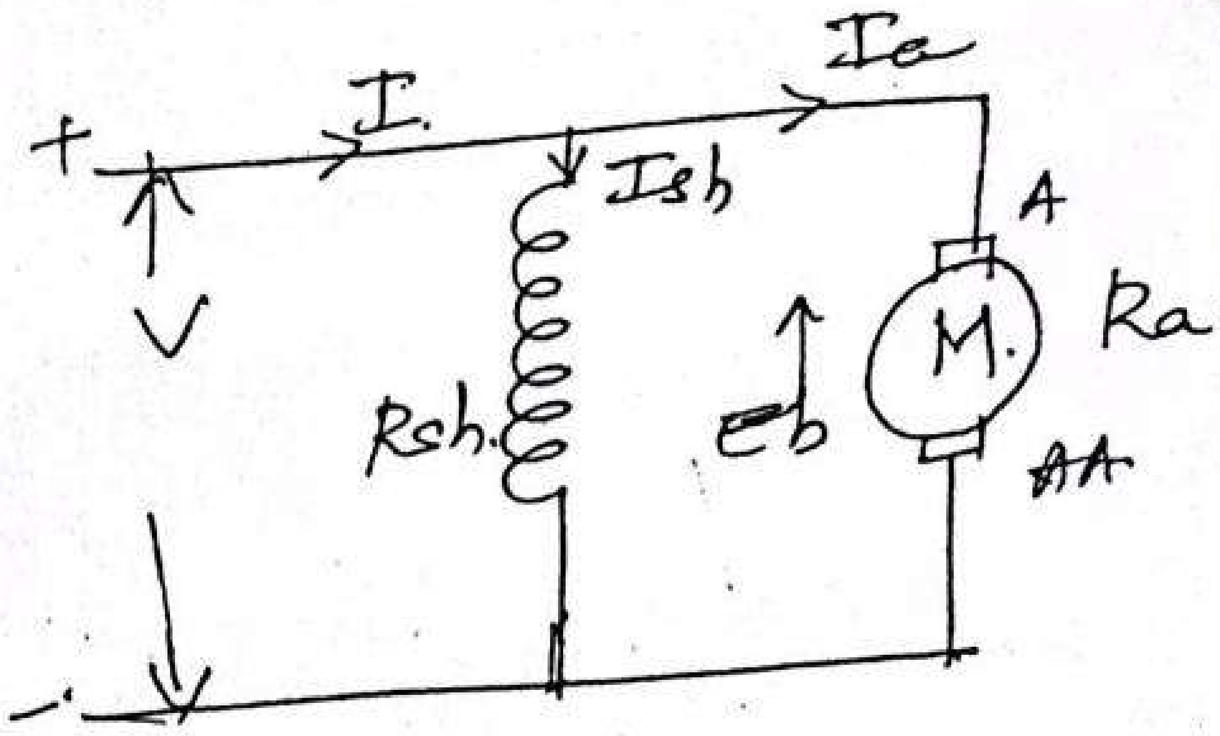


Fig. represents a DC shunt motor. In this motor, the fieldwinding is connected in parallel (shunt) with the armature winding, so that full voltage (applied) V across the armature is also got across the shunt field windg also.

∴ If the applied voltage is V, and I is the supply current then, a portion of I ie Ishunt (I_{sh}) flows through the shunt field wdg. and remaining large portion, I_a flows through the armature wdg. Usually, Rsh of the shunt field wdg. is large and the armature resist Ra is very small. Then, the shunt field current is, $I_{sh} = \frac{V}{R_{sh}}$. and

$$I_a = I - I_{sh}$$

The voltage equation is, $V = \underline{\underline{E_b + I_aR_a + BD}}$.

where $E_b \Rightarrow$ back emf.

$V \Rightarrow$ applied voltage.

$I_aR_a \Rightarrow$ armature resist drop.

$BD \Rightarrow$ brush contact drop.

Then, $E_b = V - I_aR_a - B.D$. If brush contac drop is neglected,

$$\underline{\underline{E_b = V - I_aR_a}}.$$

DC Series Motor

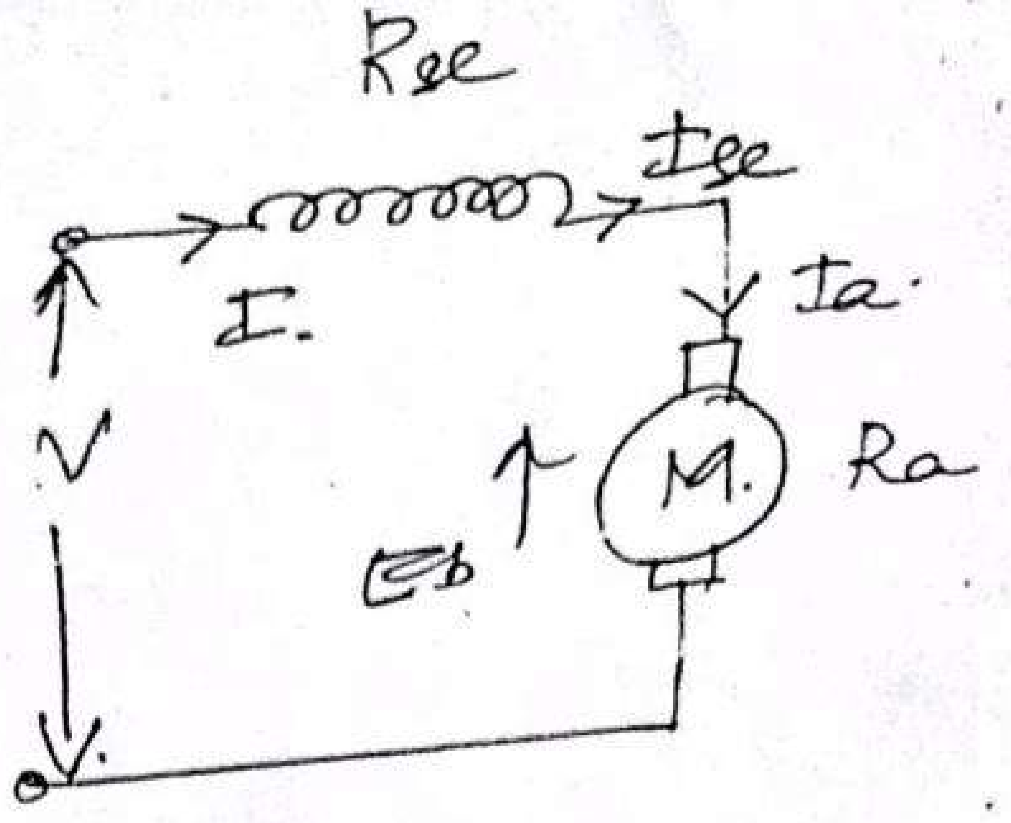


Fig shows the DC series motor. In this motor the field wdg. is connected in series with the armature wdg.

V is the applied voltage, due to which a current I flows through the line, the series field windg and also through the armature conductors.

∴ supply current I = series field curnt Ise = armature curnt Ia

$$\text{ie}\quad I = I_{se} = I_a$$

Since the series field wdg. has to carry large armature current, it should have small resistance, like that of armature wdg, Ra. Therefore, series windg is made of few thick turns of copper.

The voltage equation is given by,

$$V = E_b + I_a(R_a + R_{se}) + B.D.$$

where R_{se} → series field resist. R_a → armr. resist

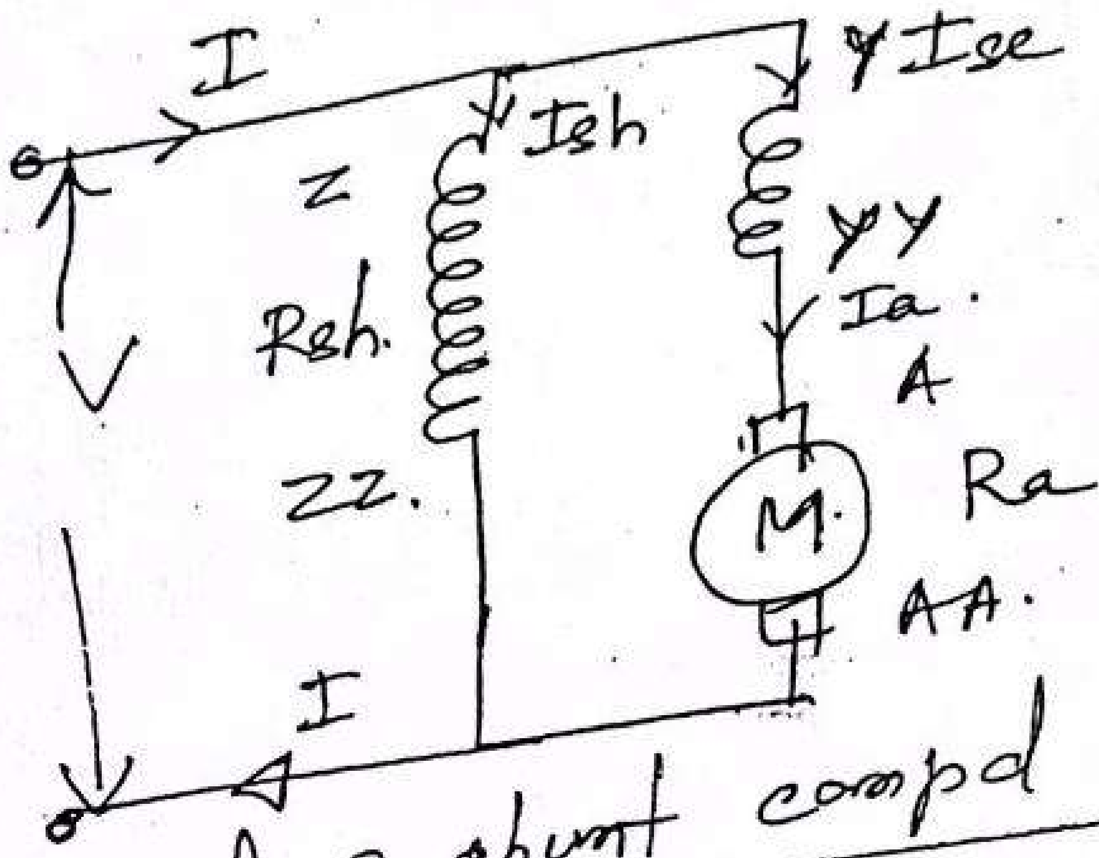
E_b → back emf. B.D → brush contact drop.

$$\therefore E_b = V - I_a(R_a + R_{se}) - B.D.$$

DC compound motor

This motor has both shunt and series field windings as shown in fig. There are two types of compound motors.

(1) Cumulative compound motor.

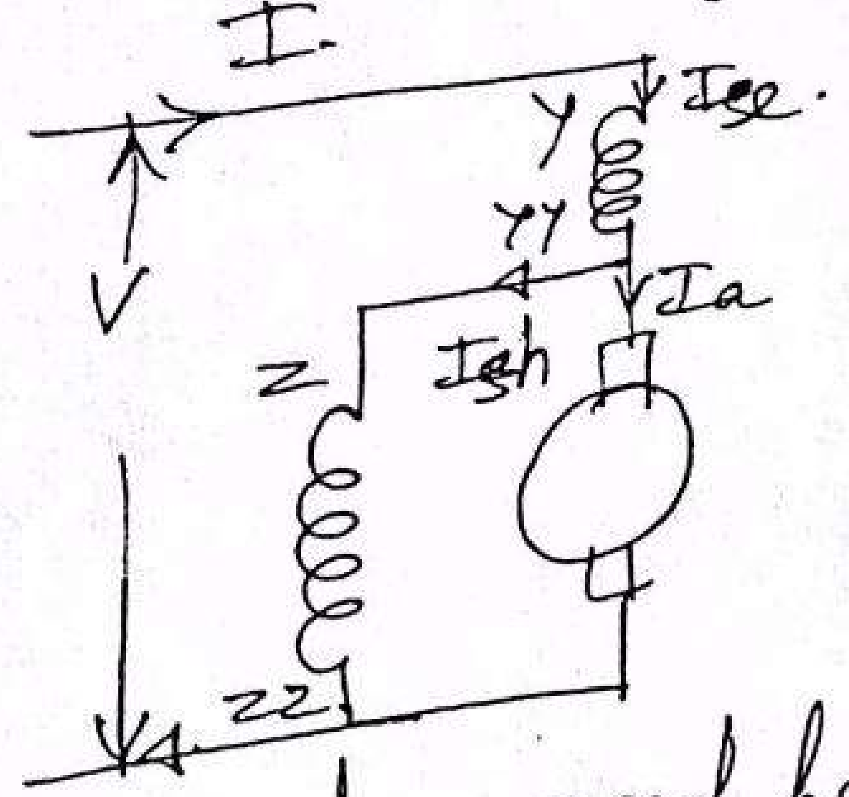


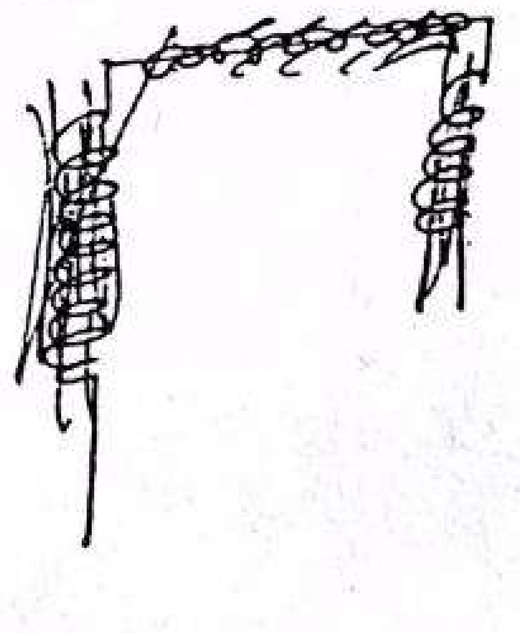
long shunt compd motor

If the flux ϕsh produced by the shunt field wdg and the flux ϕse produced by the series field wdg. are in the same direction and aid each other, then the motor is called cumulative compd. motor

Depending on the way in which the two ~~w~~field wdgs. -e connected, there are long shunt and short shunt cumulatively compounded motors.

short shunt cumulative compound motor



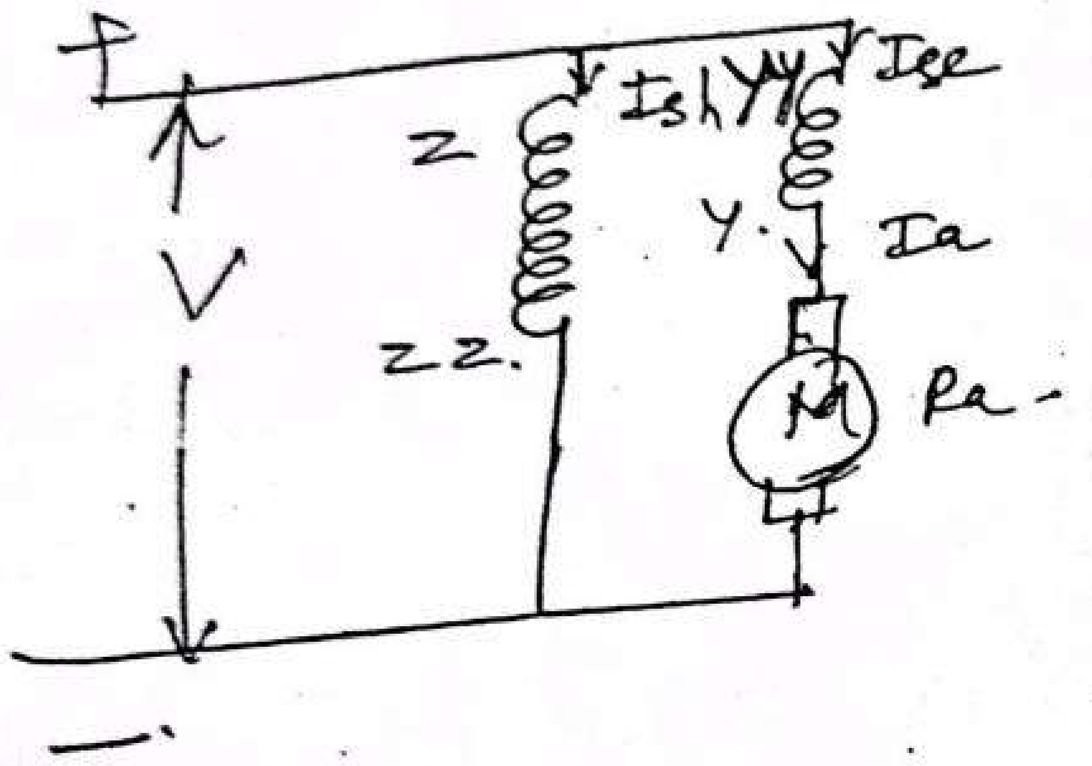


In both short shunt and long shunt cumulative compd. motors, the currents through the two field wdgs. enter the positive terminals, and hence the fluxes produce by them are in the same direction and are additive.

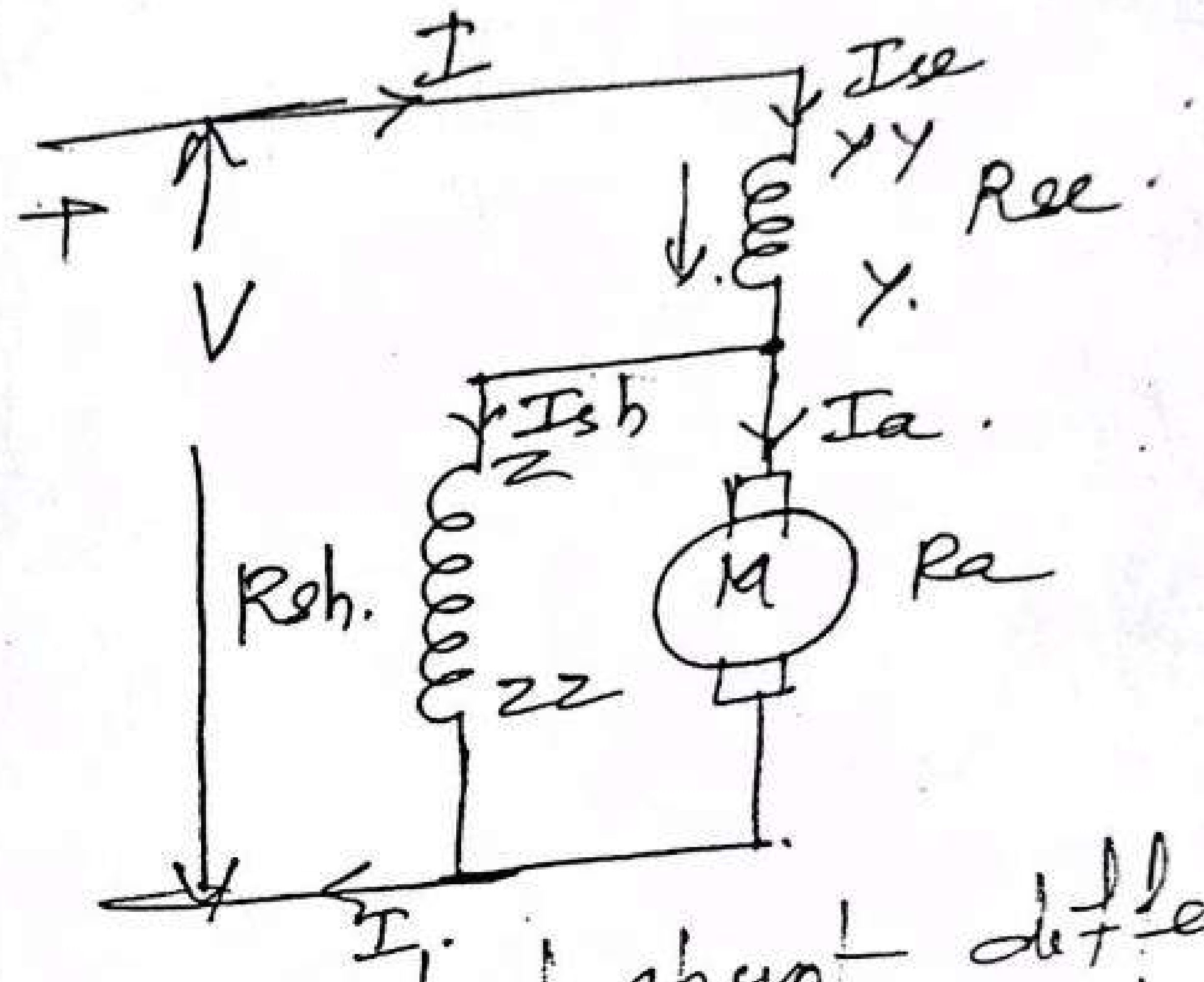
③ Differential compound motors.

If the fluxes ϕ_{sh} of the shunt field wdg and that of the series field wdg, ϕ_{se} oppose each other, then the motor is said to be differentially compounded.

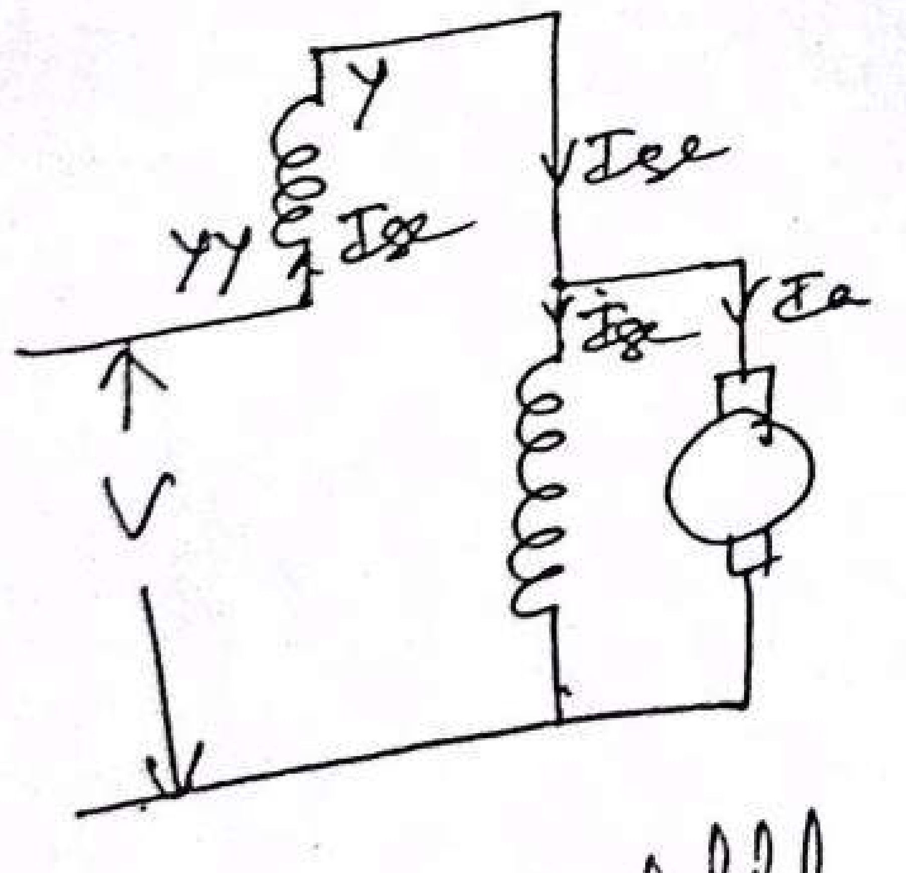
The connections for long shunt and short shunt motor are shown below.



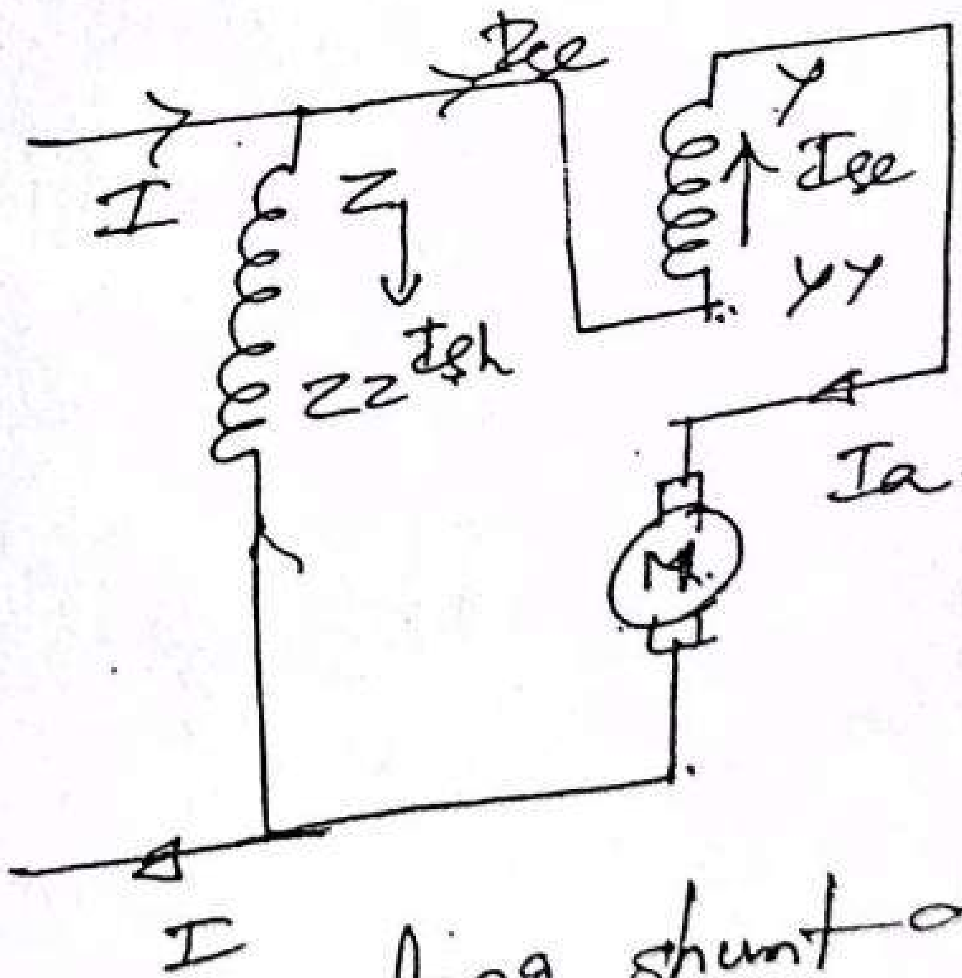
long shunt differential compound motor.



short shunt differential compound motor.



short shunt diffl.



long shunt differential

In both cumulative and differential compound motors, the following relations holdgood, for long shunt connection

$$I_{sh} = \frac{V}{R_{sh}}.$$

Long shunt motors (Cumul. & differential)

$$I_{sh} = \frac{V}{R_{sh}}$$

$$I_a = I - I_{sh}$$

$$V = E_b + I_a (R_a + R_{se}) + B.D.$$

$$\therefore E_b = V - I_a (R_a + R_{se}) - B.D.$$

For short shunt motors, either cumulative or differents

$$I_{sh} = \frac{V - I_{\cancel{a}} R_{se}}{R_{sh}}$$

$$I_a = I - I_{sh}$$

$$V = E_b + I_a R_a + \cancel{B.D.}\, I R_{se} + B.D.$$

$$E_b = V - I R_{se} - I_a R_a - B.D.$$

characteristics of DC motors.

The following are the three important characteristics o dc motors.

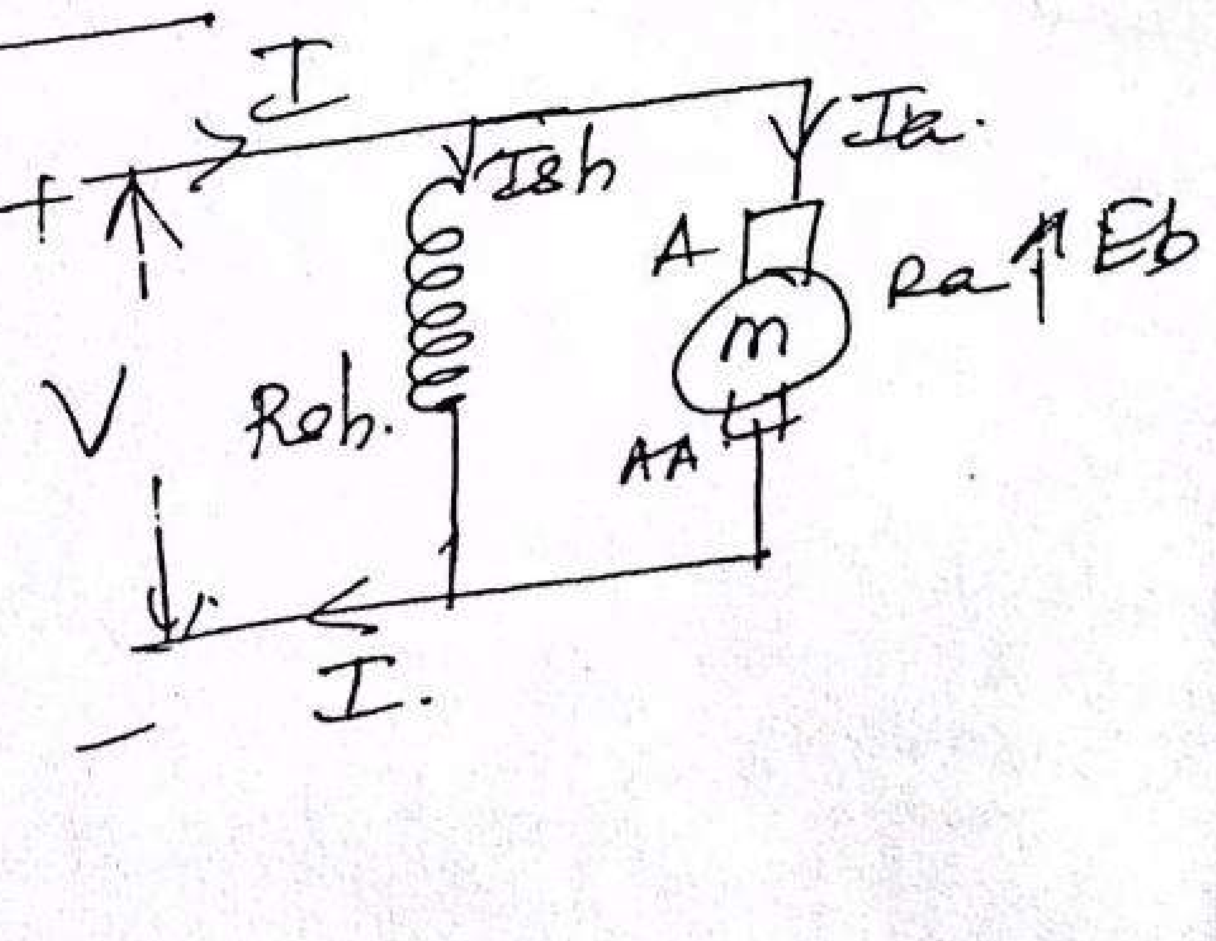
① Electrical characteristic or T_a / I_a charact.

② Speed Vs armature current or N / I_a characteristic

③ Speed Vs torque or N / T_a or mechanical charact.

(A) Shunt motor characteristics

Fig shows a dc shunt motor on load.



The torque equation of a motor is given by,

$$T_a = 0{\cdot}159\, \phi \frac{ZP}{A} I_a .$$

In this eqn, Z, P, A are constants

$\therefore T_a \propto \phi I_a$ — ①

In a shunt motor, the field current Ish remains constant irrespective of the load connected to the motor. [Even if the load current varies] from no load to fullload the field current and hence the flux due to that curnt. remains constant, since the applied voltage remains constant.

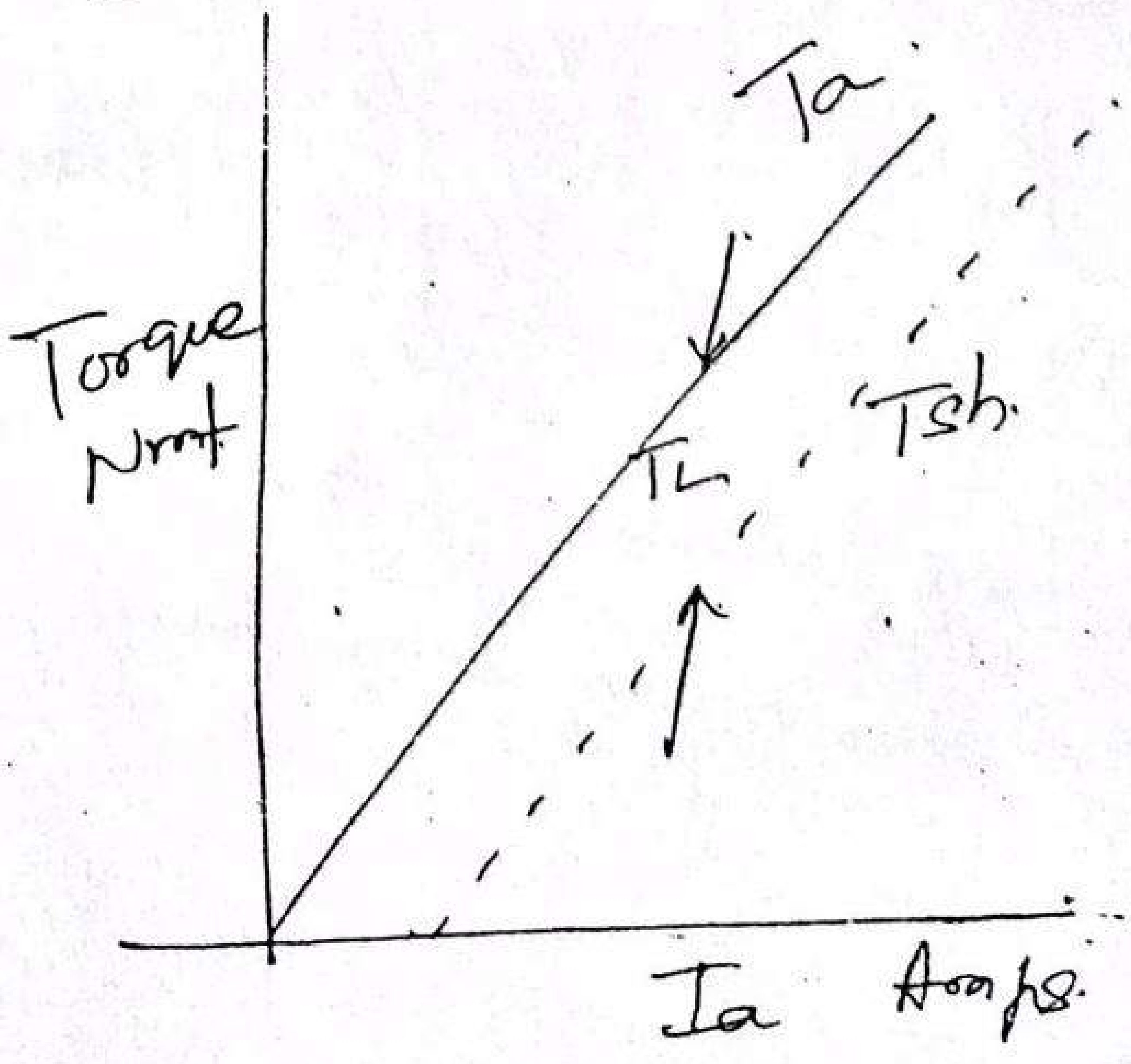
Therefore, the flux is constant for a shunt motor

∴ The eqn ① becomes,

$T_a \propto I_a$ for shunt motors.

[Thus, the torque increases with the armature current, linearly. Hence, Ta Vs Ia characteristic is a straight line passing through the origin,] [as shown below.

we know that, the shaft torque Tsh is always less than the armature torque Ta due to iron losses and mechanical losses.] Hence, Tsh line is



shown to be less than Ta by the lost torque T_L.

[Hence, the shunt motor has the medium starting torque and it cannot be used where large starting torque is required;] with heavy loads.]

② Speed Vs armature current characteristic (N/Ia)

we have the equation for back emf, $E_b = \frac{\phi Z N P}{60A}$.

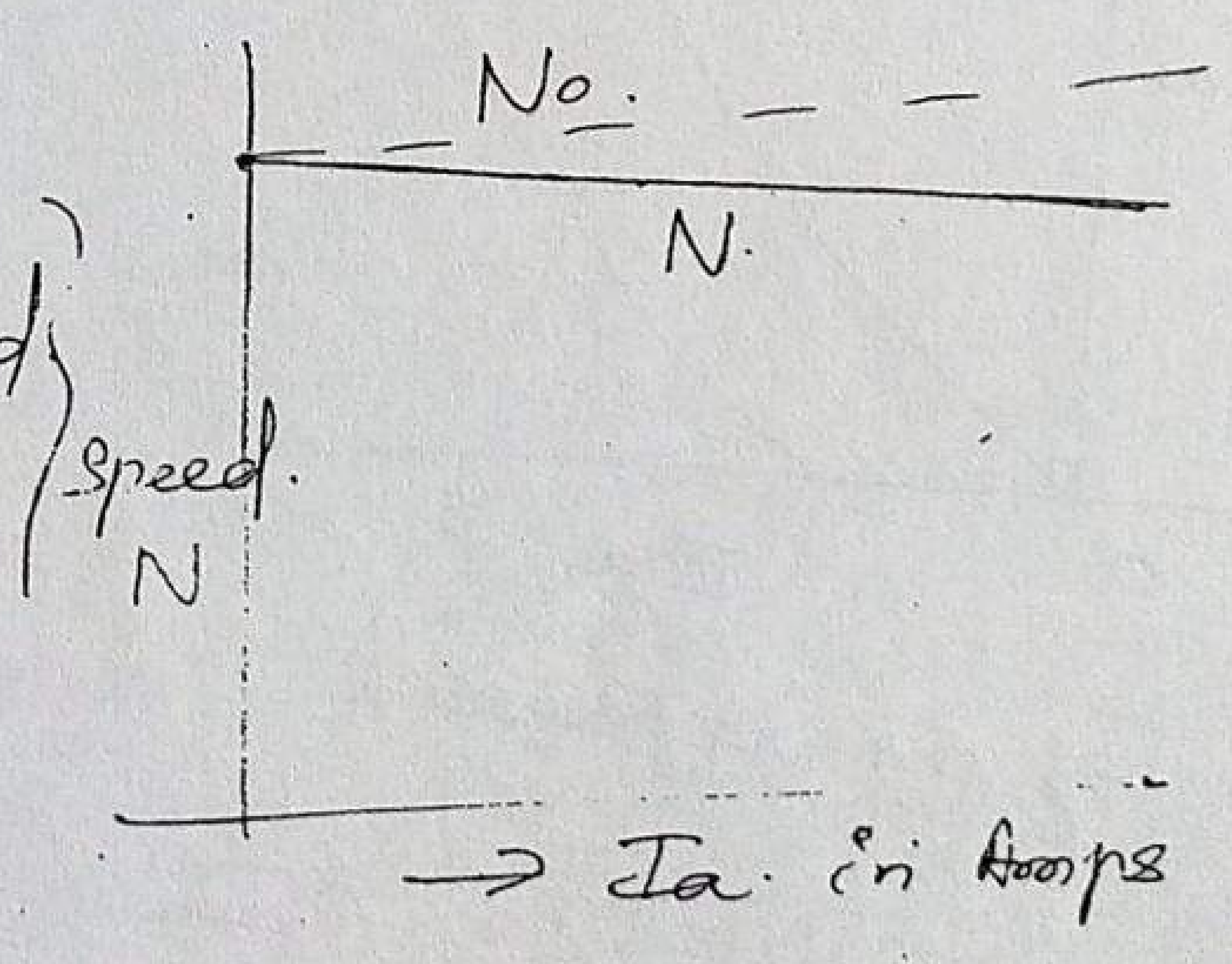
$$\therefore N \propto \frac{E_b}{\phi} \propto \frac{V - I_a R_a}{\phi}.$$

But in dc shunt motors, flux ϕ is almost constant

$\therefore N \propto V - I_a R_a$ As the load ↑ses, Ia ↑ses.

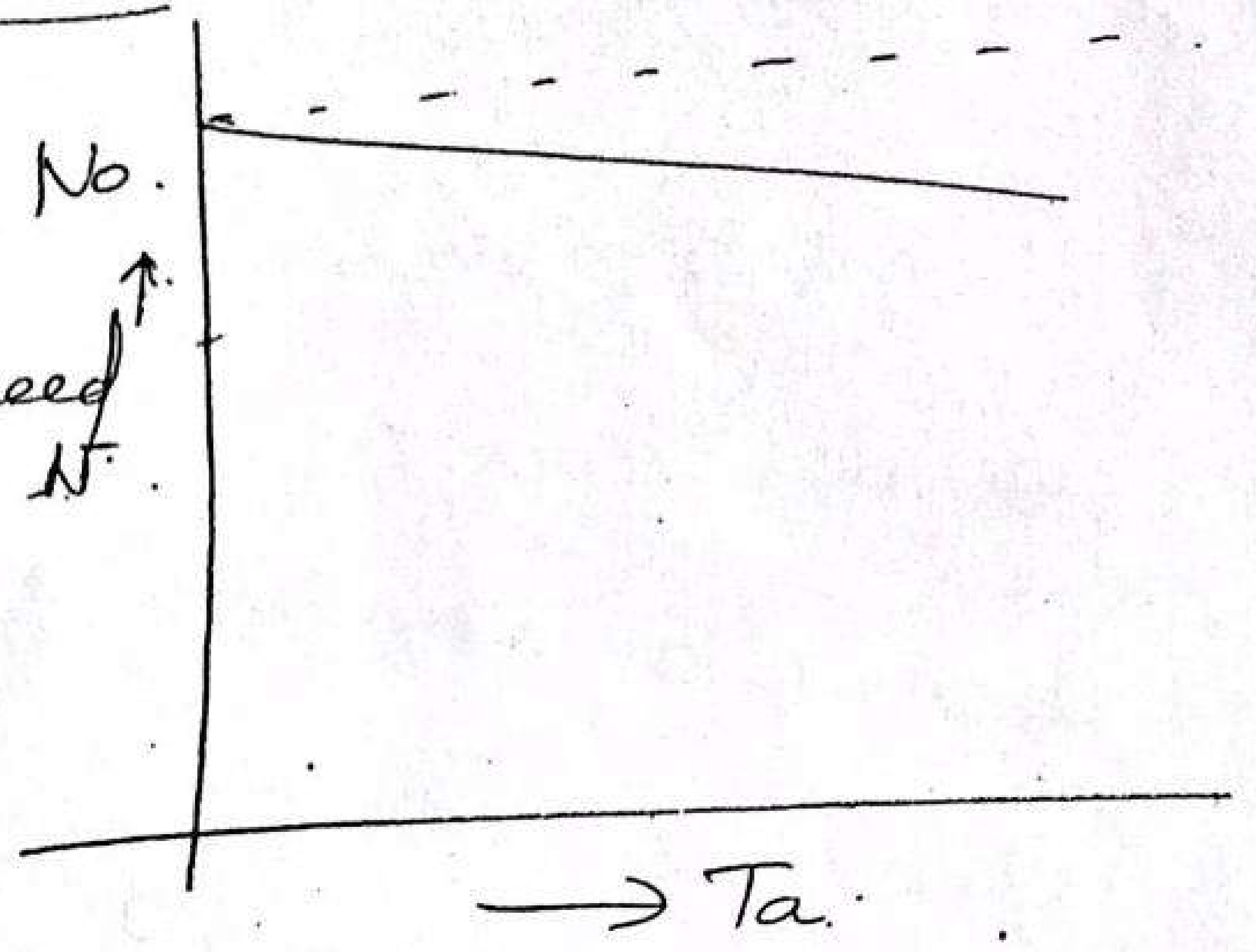
As armature current Ia increases, IaRa increases and the speed decreases. Since IaRa drop is very small the variation of speed (drop) is very small, co. w.r.t the armature curr. Therefore, the decrease in speed from no load to full load is very small, as shown in fig.

No → no load speed.
N → speed at full load



Hence, for all practical purposes, dc shunt motors can be considered as a constant speed motors.]

⑧ · N Vs Ta characteristic



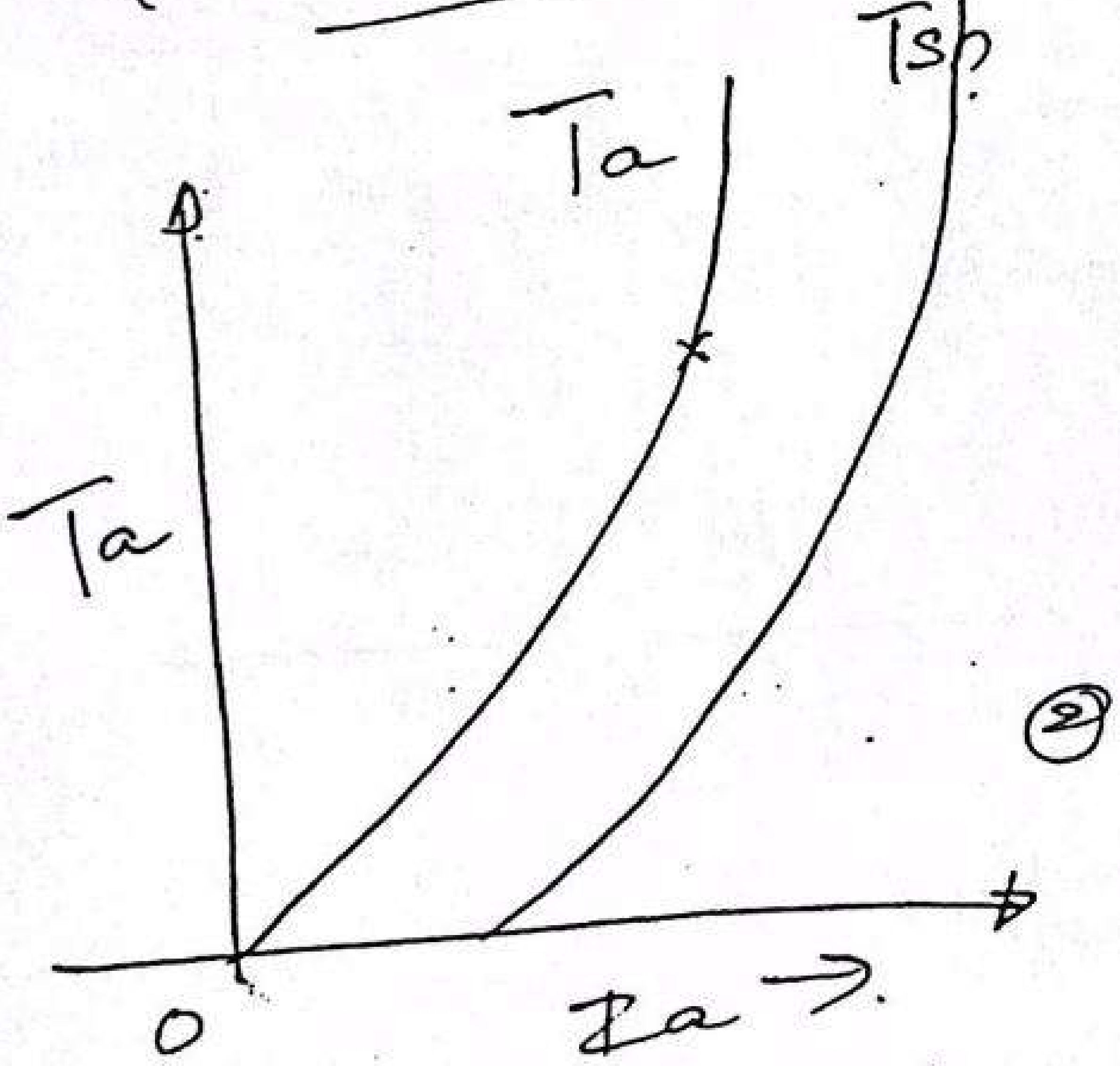
This curve is obtained by plotting the values of N and Ta for various armature currents Ia.

Since Ta $\propto$ Ia and speed N decreases with Ia . . Na $\propto \frac{1}{Ia}$,

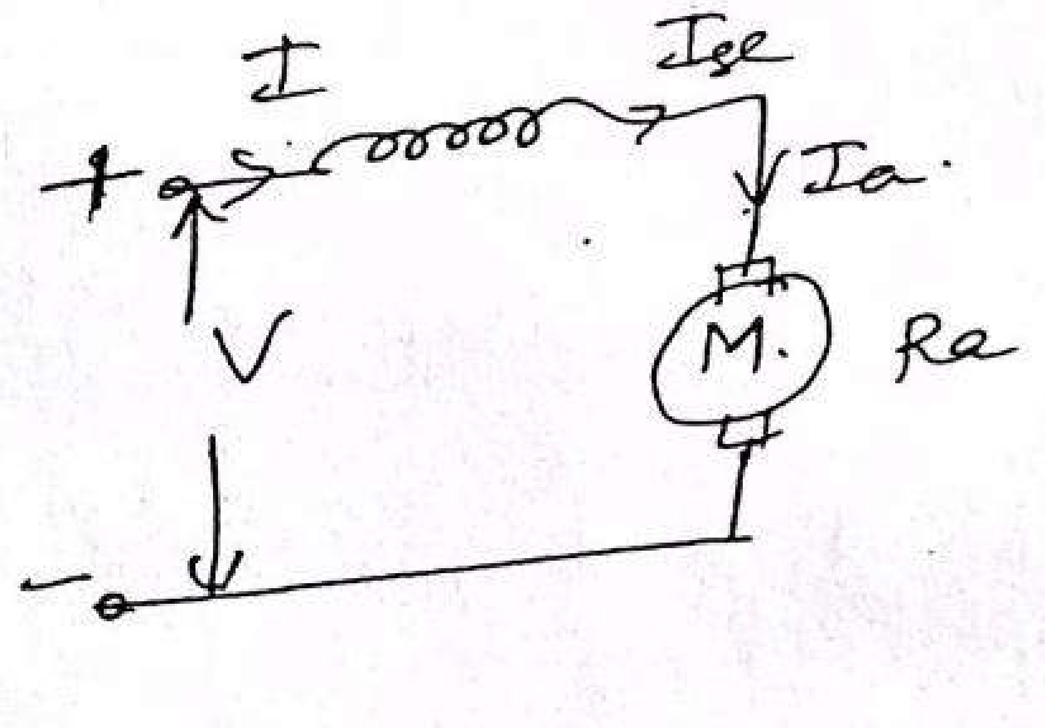
~~Ra~~ Ta $\propto \frac{1}{N}$ or N $\propto \frac{1}{Ta}$.

∴ we get the characteristic similar to N Vs Ia ch ct

2. Characteristics of a DC series motor



②.



①

@ Torque Vs Ia characteristic

Fig ① represents a dc motor on load. we know th.

Ta $\propto$ ϕ Ia

But in, series motor, the flux $\phi \propto$ Ise.

ie $\phi \propto$ Ia

∴ $Ta \propto Ia^2$

As the load on the motor increases, the current through the series winding also increases and the flux produced also increases.

Thus, since $Ta \propto Ia^2$, the Ta Vs Ia characteristic is a parabola as shown in fig. But, after the saturation of poles, the flux becomes constant and $Ta \propto Ia$ and therefore the characteristic becomes a straight line.

Thus, the starting torque is ∝l to Ia^2 and is very large and the motor is used where large starting torque is required with heavy load on the motor.

② Speed Vs Ia characteristic.

we know that, $N \propto \frac{Eb}{\phi} \propto \frac{V - Ia(Ra+Rse)}{\phi}$

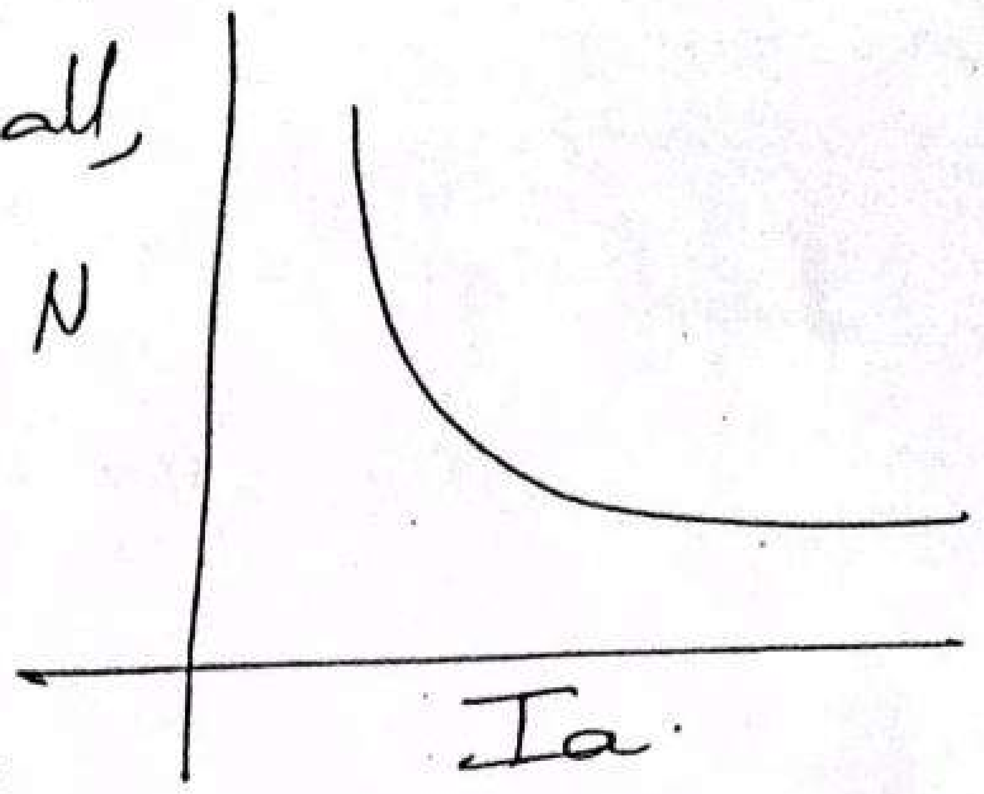
(i) As the load ↑ses, Ia increases and therefore Ia (Ra+Rse) increases. ∴ $V - Ia(Ra+Rse)$ decreases and hence the speed decreases. But the decrease in speed is negligibly small.

(ii) with load current increase, flux ϕ also increases (∵ Ise ↑ses) and hence the speed decreases, ∵ $N \propto \frac{1}{\phi}$

The decrease in speed with the increase in armature current is shown in fig. The speed varies widely and

∴ series motor is a variable speed motor.

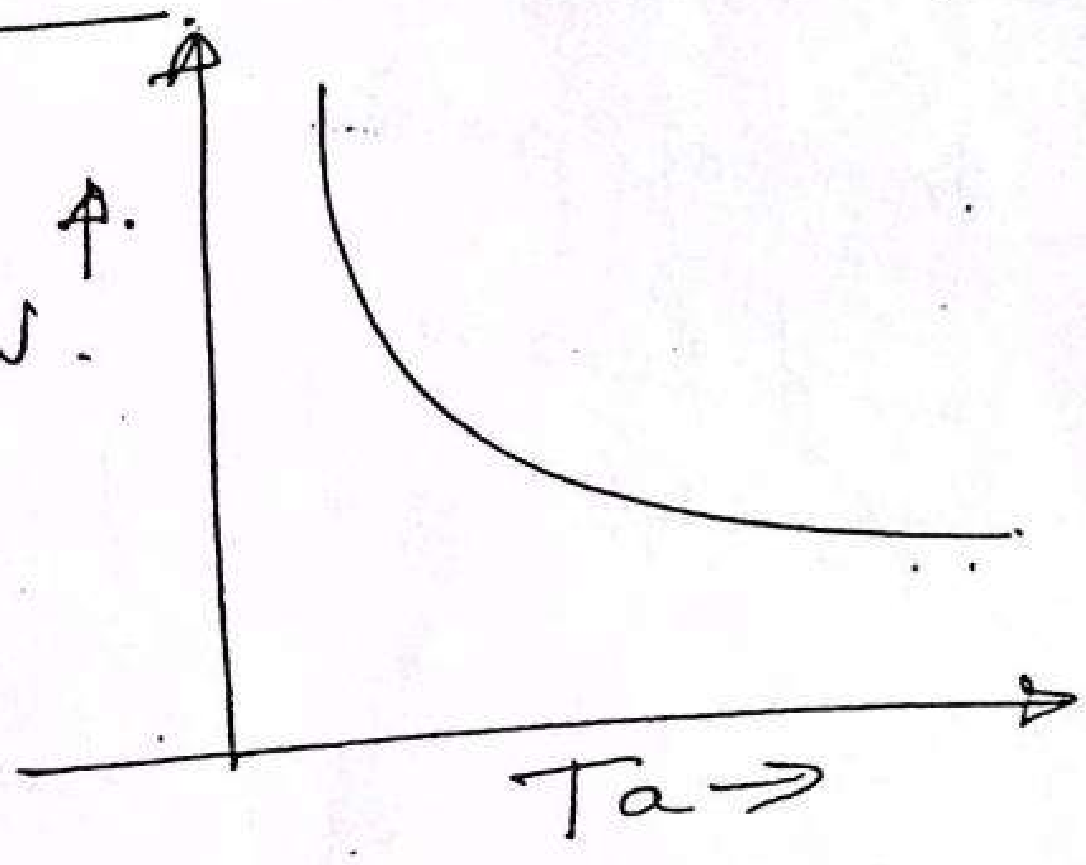
At no load, I_a is very small, and hence the speed is dangerously high.



Therefore, the series motor should never be started on no load.

(c) Speed Vs Torque characteristic

It is shown in fig. when I_a is small, N is very high.



But $T_a \propto I_a^2$.

and $N \propto \frac{1}{I_a}$ ∴ $I_a \propto \frac{1}{N}$

$$\therefore T_a \propto \frac{1}{N^2}$$

$$N^2 \propto \frac{1}{T_a}$$

$$\therefore N \propto \frac{1}{\sqrt{T_a}}$$

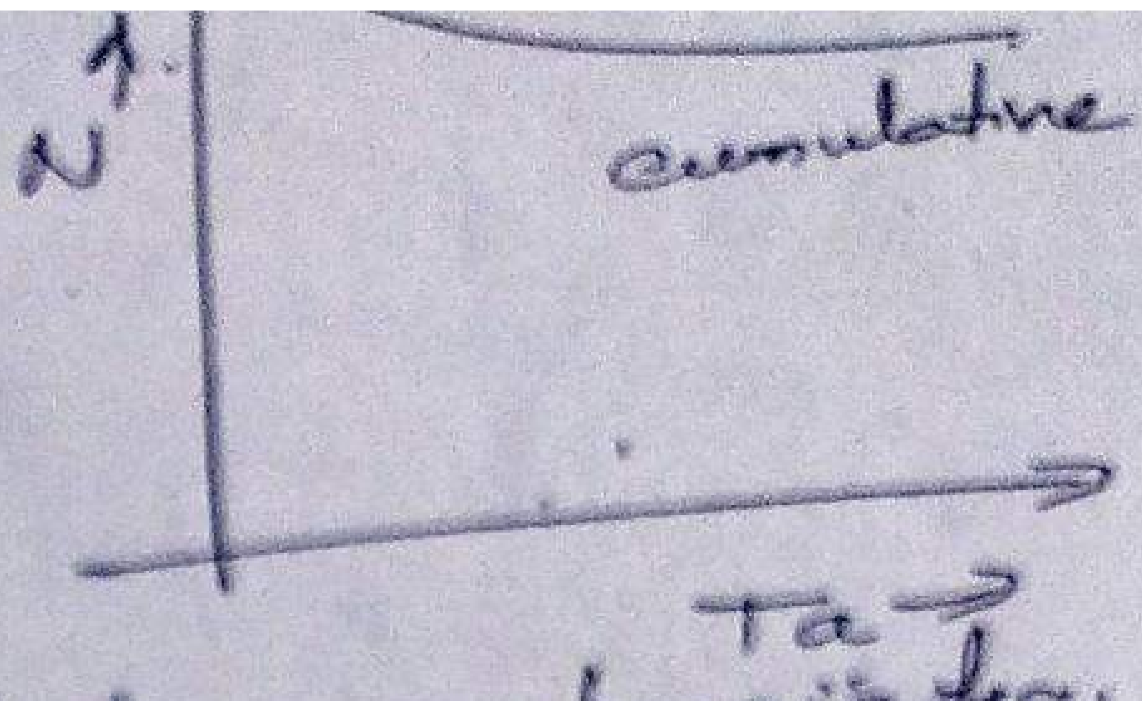
Hence, for smaller values of T_a, N is very large and vice-versa

∴ Ta

and speed decreases faster

$T_a \propto I_a \uparrow$

$T_a \propto \frac{I_a}{N}$



Differential

For diff. motors,
as the load ↑ses, Ia ↑ses.
flux decrease Ta decreases faster, as shown in fig.
and speed increases faster.

Applications of DC motors ✓

(1) DC shunt motors. — It has a medium starting torque and its speed remains almost constant from no load to full load. Hence it is used where constant speed is required and the starting torque required is not very high. i.e for lathes, pumps, fans, drilling machines, spinning and weaving machines etc

④ DC Series Motors. – applications.

This has a ~~fa~~ very high starting torque and its spe varies widely from no load to full load. Hence it is used where high starting torque and variable speed is required – such as for electric traction work, trolleys, cranes, hoists, vacuum cleaners, hairdriers.

⑤ DC Compound motors. – applications.

The characteristics of cumulatively compounded dcm is between those of shunt motor and series motor. It has high starting torque and a variable speed. ~~It~~ is used where sudden loads are applied or remov such as, punches, elevators, rolling mills, printing presse air compressors etc.

The differential compound motors are not apractically used because of its undesirable characteristics.

3 point starter

Necessity of a starter

we know that, $V = E_b + I_a R_a$.

$I_a = \frac{V - E_b}{R_a}$ ∴ I_a is controlle by E_b.

when the motor is at rest, $N = 0$. ∴ $E_b = \frac{\phi Z N P}{60A} = 0$

∴ $I_a = \frac{V - 0}{R_a}$ is very large during starting. since R_a is very small. $(<1$

DC machines — Assignment Questions

THEORY Questions

1. Derive the expression for the emf of a DC generator. (5m)

2. Sketch the various characteristics of DC shunt motor and mention its applications. (6m).

3. Explain the principle of operation of a dc motor (5m)

4. Deduce the relation between back emf and voltage applied to a short shunt compound dc motor. Explain the variation of back emf & load current w.r.t. load changes (5m).

5. Derive the expression for armature torque developed in a dc motor. (6m)

6. Show that speed of a dc motor is directly proportional to the back emf and inversely ∝l to the flux/pole(4m).

7. Mention the classification of dc generators (4m)

8) Discuss the characteristics of Ta/Ia and N/Ia for a series motor. (6m)

9) What are the functions of yoke, armature, poles and brushes in a dc generator? (4m)

10) Sketch and label the parts of a DC machine & state the function of each part. (7m)

Scanned by TapScanner

11. Explain with necessary diagrams the speed-load
characteristics of series and shunt motors. Mention
the important application of series & shunt motors. (6m)

12. Give reasons : ① The armature winding is placed
on the rotor in a dc machine. ② Shunt motors
are used for constant speed applications. ③ Series motors
should not started without proper load. (6m)

13 Draw the schematic representation of series, shunt
and long shunt compound generators. In each case,
write the voltage & current balance equations. (6m)

4) what is back emf in a dc motor? what is its
significance? (6m)

15 Explain the necessity of a starter for dc motor.

16 Explain the characteristics of DC series motor
with a neat diagm.

Synchronous Generator or Alternator

Introduction

It is known that the electric supply used now-a-days for commercial, as well as domestic purposes, is of alternating type. Similar to d.c machines, the a.c machines associated with alternating voltages, are also classified as generators and motors.

Machines generating alternating emf are called **alternators or synchronous generators**. While the machines accepting input from a.c supply to produce a mechanical output are called synchronous motors. Both these machines work at a specific **constant speed** called synchronous speed and hence in general are called synchronous machines.

Alternator is a 3 phase A.C. generator which is mainly used in power stations to generate 3 phase AC. It is also called synchronous generator since it runs at synchronous speed which is given by, Ns = 120f / P where f is frequency of generated emf and P is No.of poles. Since frequency of generated e.m.f. is to be constant speed is to be constant for an alternator. The alternator has a field system and an armature like DC generator. But here, the field system is rotating and the armature is stationary.

An alternator operates on the same fundamental principle of electromagnetic induction as a d.c. generator i.e., when the flux linking a conductor changes, an e.m.f. is induced in the conductor. Hence it needs - magnetic flux & a coil.

To generate electricity in a coil either the coil should rotate with respect to a magnetic field or a magnetic field should rotate with respect to the coil. In alternator, second method is used.

The group of coils used in alternator in the form of windings – ARMATURE WINDINGS. They are placed inside slots in ARMATURE CORE made up of silicon steel laminations. The electromagnets used are called magnetic FIELD POLES.

The difference between d.c. generators and alternators are as follows:

In alternators, the armature winding produces A.C. and it delivers A.C. Therefore, commutators are not required like d.c. generators and hence the construction is simple.

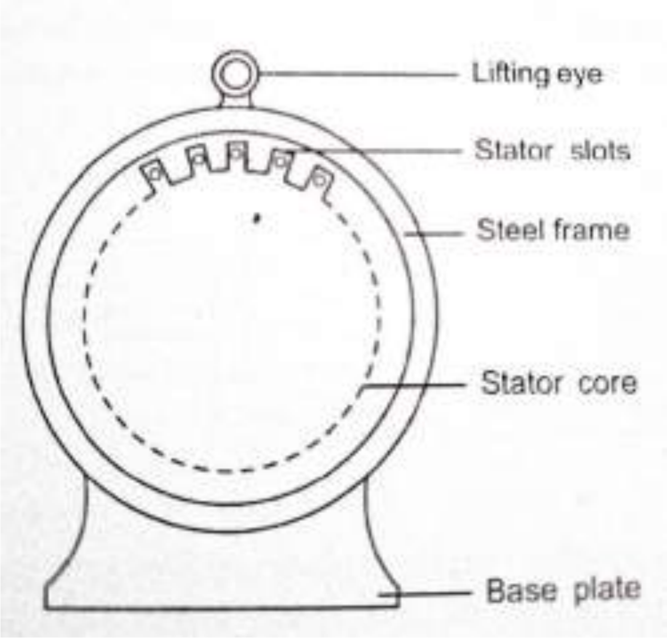
In d.c. generators the armature rotates and the field is stationary. But in Alternators, the field system is rotating and the armature is stationary.

Construction of an Alternator or Synchronous generator

Q. Explain the construction of two types of Alternators with neat figures.

An alternator has two parts- **stator** –which is stationary part and **rotor** which is rotating part.

STATOR



Stator is stationary part and is called ARMATURE which is an iron ring, formed of laminations of special magnetic iron or steel alloy.

Parts of STATOR

Frame- The Stator consists of a frame which is made up of mild steel or cast steel plates welded together to form a cylindrical drum. It is the outer part of the Alternator and protects the machine from moisture and other impurities. Its main function is to support the stator core and the field winding. It acts as a covering, and it provides protection and mechanical strength to all the inner parts of the induction motor.

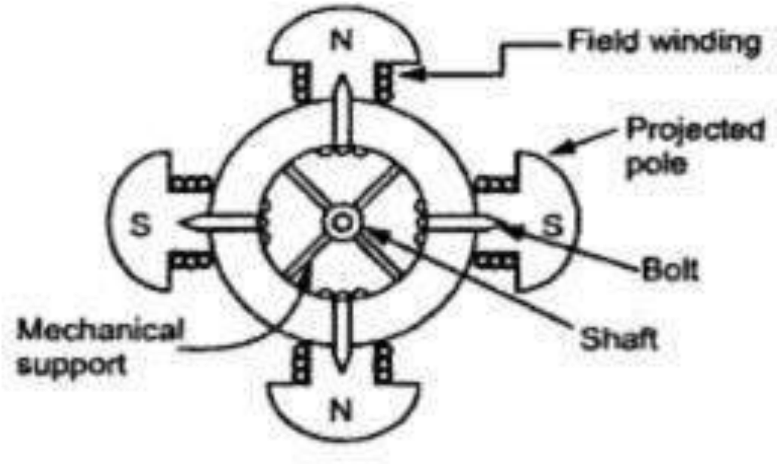
Armature- The armature has armature core and armature winding. Armature coils are stationary 3 phase wound coils. The armature core is made of laminations of special steel alloy i.e. silicon steel to reduce eddy current loss. The laminations are insulated from each other and pressed together to form the core. The core has uniform slots on its inner periphery to accommodate armature conductors or winding. The frame has holes cast in it and radial ventilating ducts in the laminations help to cool the machine.

ROTOR

Rotor is rotating part and is called FIELD SYSTEM which has magnetic FIELD POLES producing magnetic flux. Rotor poles produce a rotating magnetic field and this rotating magnetic flux induces electricity in the armature coils. Rotor is similar to that of DC generator which is excited from a separate source of 125V or 250 V supply. The excitation is provided from a small DC shunt or compound generator known as exciter.

There are two types of rotors-
Salient Pole Rotor and
Smooth Cylindrical or non-Salient Pole Rotor
Hence we have two types of Alternators- Salient Pole Alternator and non-Salient Pole Alternator or Turbo Alternator.

Salient Pole Rotor

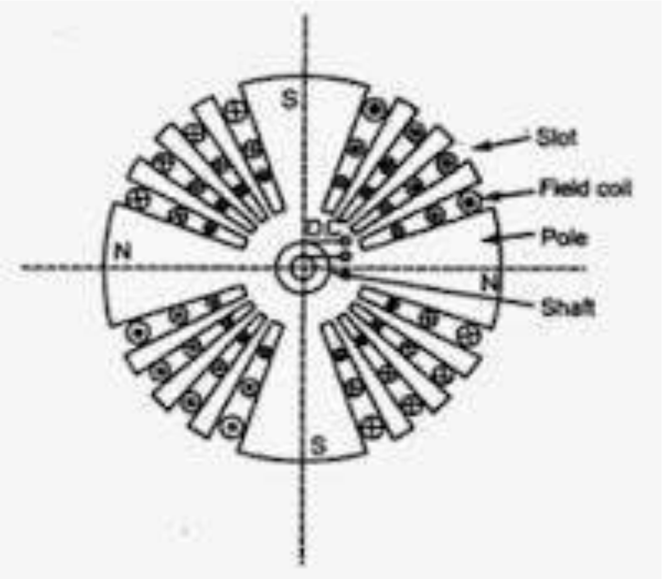


The alternator with salient pole rotor is called Salient Pole Alternator. The **salient pole** type of rotor consist of large number of **projected poles** (salient poles) with their cores bolted to a heavy magnetic wheel of cast iron or steel. The projected poles are made up from laminations of steel to reduce heating due to eddy current loss. The rotor winding or field coils ate provided on these poles and it is supported by pole shoes. The dc voltage is fed to the field coils through two carbon brushes and two slip rings mounted on the shaft of the alternator.

Features of salient pole rotor

1. Salient pole rotors have large diameter and shorter axial length.
2. They are generally used in low and medium speed alternators,say 100 RPM to 1000 RPM.
3. These are usually engine driven and rotate on Horizontal axis.
4. These rotors cause excessive windage loss if driven at higher speeds and produce more noise.
5. In this alternator, the airgap is not uniform. Hence Flux distribution is relatively poor than non-salient pole rotor, hence the generated EMF waveform is not as good as cylindrical rotor.
6. Salient pole construction cannot be made strong enough to withstand the mechanical stresses due to higher speeds.
7. Salient pole rotors generally need damper windings to prevent rotor oscillations during operation.
8. As the rotor speed is lower, more number of poles are required to attain the required frequency. Typically number of salient poles is between 4 to 6.
9. Salient pole synchronous generators are mostly used in hydro power plants.

Smooth cylindrical type or non-Salient Pole Rotor



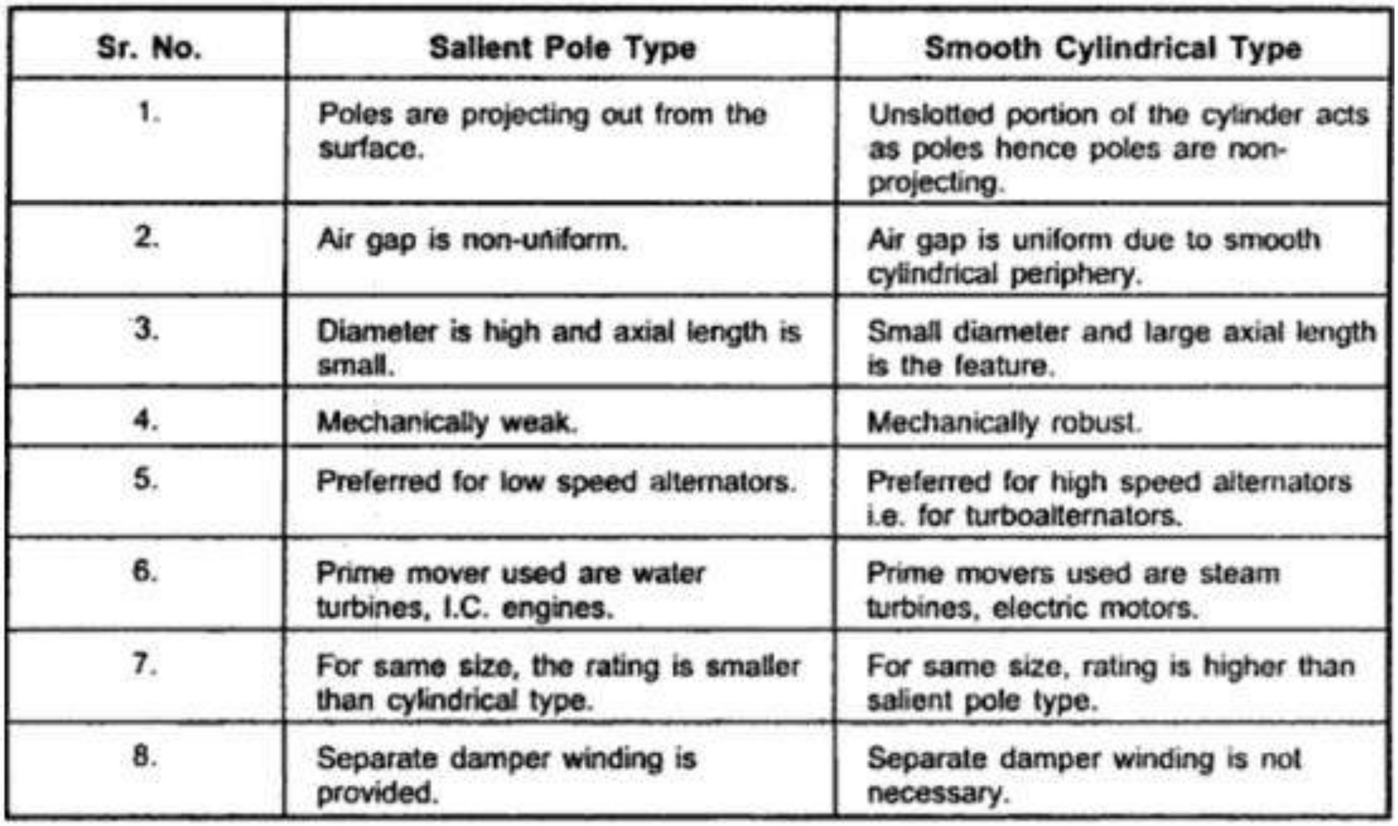
The alternator with this type of rotor is called **non Salient Pole Alternator or Turbo Alternator** since they are driven by turbines. This rotor consists of a smooth solid steel cylinder, having a number of slots running parallel to the shaft to accommodate the field coils. The unslotted portions of the cylinder itself act as the poles. There are two or four unslotted polar areas which are surrounded by the field coils. The poles are not projecting out and the surface of the rotor is smooth which maintains a uniform air gap between stator and rotor.

Features of Non salient pole type or smooth cylindrical type rotor

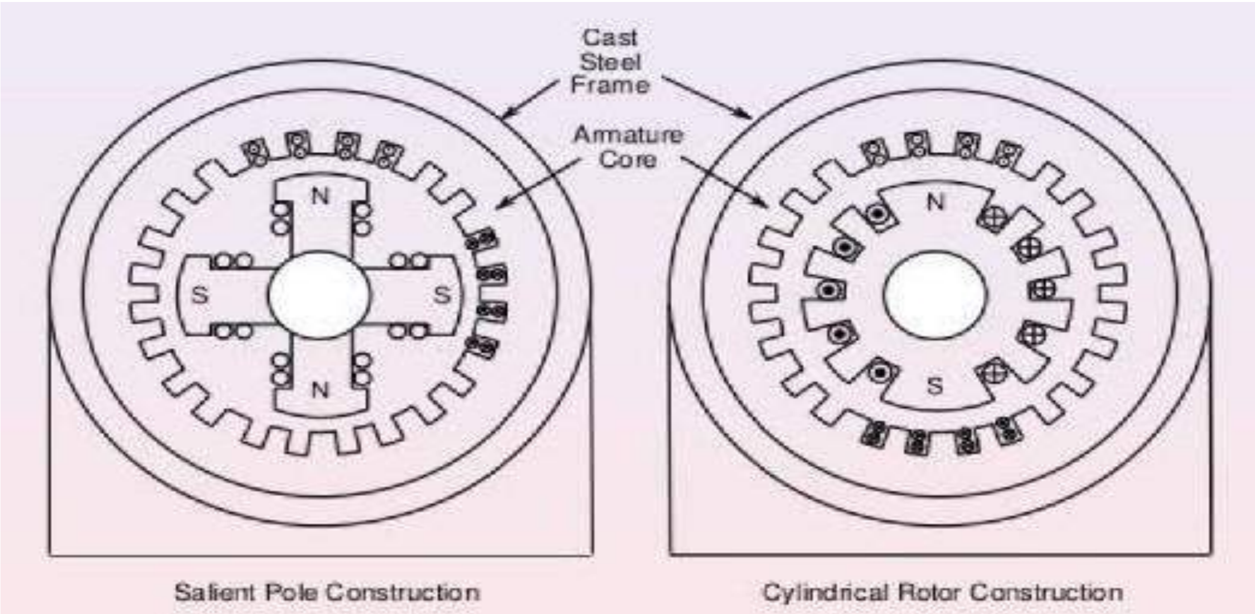
1. Non-salient pole rotors are cylindrical in shape having parallel slots on it to place rotor windings. It is made up of solid steel. Sometimes, they are also called as drum rotor.
2. They are smaller in diameter but have longer axial length. This is to keep peripheral speed within limits.
3. Cylindrical rotors are mechanically very strong and thus preferred for **high-speed alternators** ranging between 1500 to 3000 r.p.m. Hence Number of poles is usually 2 or 4.
4. They Run on VERTICAL axis.
5. Windage loss and hence the noise is less as compared to salient pole rotors.
6. Air gap is uniform and flux distribution is sinusoidal and hence gives better EMF waveform.
7. This type of construction gives better balance and hence Damper windings are not needed in non-salient pole rotors.
8. Their construction is robust as compared to salient pole rotors.
9. Non-salient pole rotors are used in nuclear, gas and thermal power plants.

2. Compare Salient pole and smooth cylindrical Rotors if Alternators.

COMPARISON OF SALIENT POLE AND SMOOTH CYLINDRICAL ROTORS



Sr. No.	Salient Pole Type	Smooth Cylindrical Type
1.	Poles are projecting out from the surface.	Unslotted portion of the cylinder acts as poles hence poles are non-projecting.
2.	Air gap is non-uniform.	Air gap is uniform due to smooth cylindrical periphery.
3.	Diameter is high and axial length is small.	Small diameter and large axial length is the feature.
4.	Mechanically weak.	Mechanically robust.
5.	Preferred for low speed alternators.	Preferred for high speed alternators i.e. for turboalternators.
6.	Prime mover used are water turbines, I.C. engines.	Prime movers used are steam turbines, electric motors.
7.	For same size, the rating is smaller than cylindrical type.	For same size, rating is higher than salient pole type.
8.	Separate damper winding is provided.	Separate damper winding is not necessary.



Salient Pole Construction

Cylindrical Rotor Construction

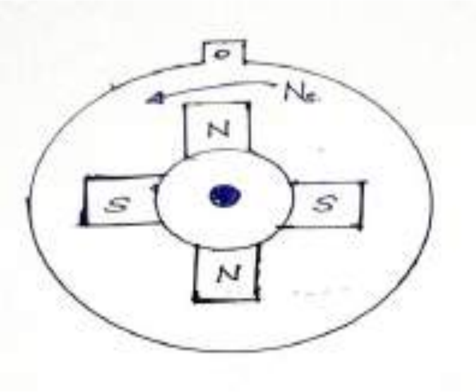
3. Explain the working principle of the Alternator.

Working principle of alternators and frequency of induced emf

An alternator operates on the fundamental principle of electromagnetic induction i.e., when the flux linking a conductor changes, an emf is induced in the conductor. It has a field system which is rotating and an armature which is stationary. Rotor produces a rotating magnetic field and rotating magnetic flux associated with the rotor induces electricity in the armature coils. Rotor poles are excited from a separate DC source of 125V or 250 V supply. The excitation is provided from a small DC shunt or compound generator known as exciter which is mounted on the shaft of the alternator which supplies dc for the field windings. When the rotor rotates, the stator conductors are cut by the magnetic flux and the e.m.f. is induced in the stator 3 phase windings. Since the rotor magnetic poles are alternatively N and S, they induce alternating emf and its frequency depends on the number of poles and is given by, f = Ns P / 120.

Frequency of Induced EMF

Let P = Number of poles
Ns = Synchronous speed of the rotor in r.p.m
f = Frequency of induced emf in Hz.



Consider a single conductor in a slot of the stator as shown in fig. Let the rotor with N and S poles rotate with synchronous speed of Ns in the ACW direction. When the North pole sweeps across the conductor, +ve half cycle of emf is induced and when the South pole sweeps across the conductor, -ve half cycle of emf is induced in it. Thus one pair of poles induce one cycle of emf in one conductor.

No. of cycles of emf induced in one revolution = $\frac{P}{2}$

No. of revolutions per second = $\frac{Ns}{60}$

Therefore,

frequency of emf induced = No. of cycles of emf/sec

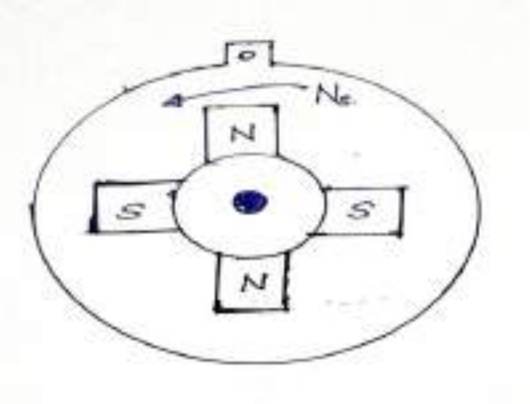
= No.of cycles of emf induced in one revolution x No.of revolutions/sec

$$f = \frac{P}{2} \times \frac{Ns}{60}$$

$$\mathbf{f = \frac{NsP}{120}}$$

4. Derive the emf equation of a Synchronous generator by considering the Pitch factor and the Distribution factor.

EMF equation of an Alternator or Synchronous generator



Let

Φ = Flux per pole, in Wb

P = Number of poles

f = Frequency of induced emf in Hz

Z = Total number of stator conductors

Zph = No. of conductors per phase connected in series =Z/3 = 2Tph

Tph = No.of turns per phase

Ns = Synchronous speed in r.p.m

$Ns = \frac{120f}{P}$ {Ns - 60 sec 60x1 = Ns x dt , dt= 60/Ns

1 - dt=? }

Consider a single conductor placed in a slot as shown in fig.

According to Faradays laws of E.M.I.,

The average value of emf induced in a conductor = $d\Phi/dt$

For one revolution of a conductor,

Total flux cut in one revolution = Φ x P

Time taken for one revolution = 60/Ns seconds.

Average emf induced per conductor = $\frac{\text{Flux cut in one revolution}}{\text{Time taken for one revolution}}$

$= \frac{\Phi P}{60/Ns}$

Eav/ conductor $= \frac{\Phi P Ns}{60}$

Average emf induced per phase = Average emf induced per conductor X No. of conductors per phase

Average emf induced per phase = $\frac{\Phi P Ns}{60}$ x Zph

But $Ns = \frac{120f}{P}$

Therefore, $$E_{av}/\text{phase} = \frac{\Phi P Z_{ph} \times 120f}{60 \quad P}$$

$$= 2f\,\Phi\, Z_{ph} \text{ volts}$$

For a sinusoidal emf, Form factor = $$\frac{E\ r.m.s.}{E_{av}} = 1.11$$

Therefore, $$E\ r.m.s.\ /\text{phase} = E_{av} \times 1.11$$

$$= 2f\,\Phi\, Z_{ph} \times 1.11$$

$$\mathbf{E\ ph = 2.22f\,\Phi\, Zph \text{ volts}}$$

$$\mathbf{E\ ph = 4.44f\,\Phi\, Tph \text{ volts}}$$

This equation is derived by assuming that the stator winding is full pitched and that all the conductors are concentrated in a single slot. But in practice, the coils are **short pitched** and the conductors are uniformly **distributed** throughout the periphery of the stator. Hence **the pitch** factor Kp and distribution factor Kd are to be considered and the emf induced gets reduced by a small quantity.

Hence the emf equation is,

$$Eph = 2.22f\,\Phi\, Zph\ Kp\ Kd \text{ volts}$$

For Star connected stator winding,

Line voltage is, $E_L = \sqrt{3}\ Eph$

$$\mathbf{E_L} = \sqrt{3}\ (2.22f\,\Phi\, Zph\ Kp\ Kd) \text{ volts}$$

Where, Kp is the pitch factor or chording factor (Kc)

Kp = cos ($\alpha/2$) where α is short pitched angle

And Kd is the distribution factor

$$Kd = \frac{\sin(m\,\beta/2)}{m\sin(\beta/2)}$$

where
m = No.of slots/pole/phase = S/ 3P

$$\beta = \text{Slot angle} = \frac{180}{\text{No.of slots/pole}} = \frac{180\,P}{S}$$

The winding factor Kw = Kp Kd
Kp =1 for full pitched winding, then Kw =Kd
Kd = 1 for Concentrated winding

5. Explain the advantages of using stationary armature in Alternators.

Advantages of stationary armature and rotating field system .

The field winding of an alternator is placed on the rotor and is connected to d.c. supply through two slip rings. The 3-phase armature winding is placed on the stator. This arrangement has the following advantages:

1. The generated voltage can be directly connected to load without using the brushes.

2. It is easier to insulate stationary armature for high generated voltages of the order of 11kV to 33kV.

It is because they are not subjected to centrifugal forces and also extra space is available due to the stationary arrangement of the armature.

3. Only two slip rings are required for supplying d.c. to the field winding on the rotor. Since the exciting current is small, the slip rings and brush gear required are of light construction and can be easily insulated for low voltages of the order of 110V to 220V.

4. The Armature windings can be easily braced to prevent any deformation due to short circuit currents.

5. Due to simple and robust construction of the rotor, higher speed of rotating d.c. field is possible. This increases the output obtainable from a machine of given dimensions.

Alternators-Principle, emf equation

Pitch factor (Kp) or Chording factor(Kc) or Coil span factor

Coil Pitch or Coil Span

The distance between the two sides of an individual coil of an AC armature winding is termed the **coil pitch**.

Coil span is defined as the peripheral distance between two sides of a coil, measured in term of the number of armature slots between them. That means, after placing one side of the coil in a particular slot, after how many conjugative slots, the other side of the same coil is placed on the armature. This number is known as coil span.

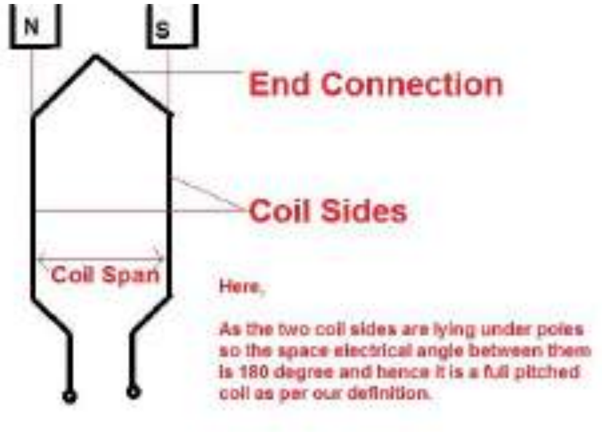
Pole Pitch

The **pole pitch** is defined as peripheral distance between center of two adjacent poles in machine. This distance is measured in term of armature slots or armature conductor come between two adjacent pole centers.

Pole Pitch is equal to the total number of armature slots divided by the number of poles in the machine. If there are 96 slots on the armature periphery and 4 numbers of poles in the machine, the numbers of armature slots come between two adjacent poles centres would be 96/4 = 24. Hence, the **pole pitch** of that machine would be 24. As we have seen that, pole pitch is equal to total numbers of armature slots divided by total numbers of poles, we alternatively refer it as armature slots per pole.

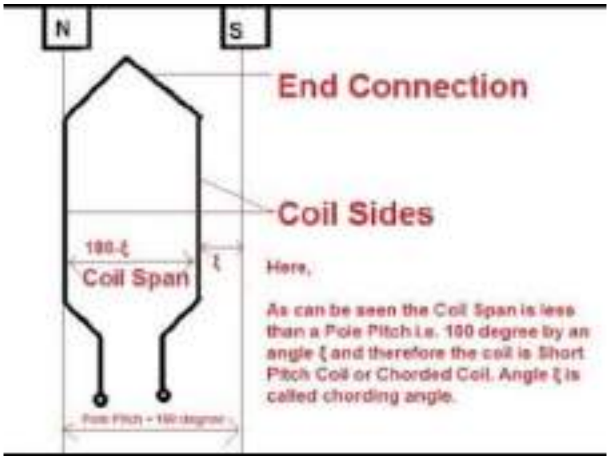
If the coil span is equal to the pole pitch, then the **armature winding** is said to be **full – pitched**. In this situation, two opposite sides of the coil lie under two opposite poles. Hence emf induced in one side of the coil will be in 180^o phase shift with emf induced in the other side of the coil. Thus, the total terminal voltage of the coil will be **direct arithmetic sum** of these two emfs.

If the coil span is less than the pole pitch, then the winding is referred as **short pitched** or fractional pitched. In this coil, the phase difference between induced emfs in two sides, less than 180°. Hence resultant terminal voltage of the coil is **vector sum** of these two emfs and it is less than that of full-pitched coil.



Here,

As the two coil sides are lying under poles so the space electrical angle between them is 180 degree and hence it is a full pitched coil as per our definition.



Here,

As can be seen the Coil Span is less than a Pole Pitch i.e. 100 degree by an angle ξ and therefore the coil is Short Pitch Coil or Chorded Coil. Angle ξ is called chording angle.

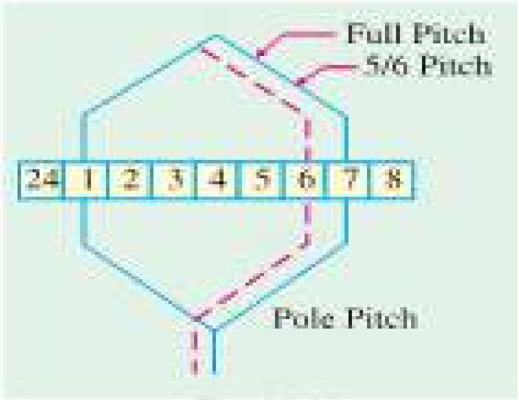
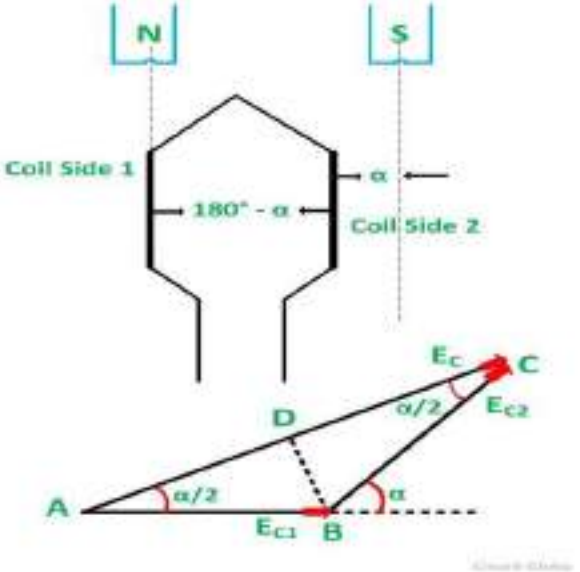


Fig. 37.16



As shown in Fig. above, if the coil sides are placed in slots 1 and 7, then it is full-pitched. If the coil sides are placed in slots 1 and 6, then it is short-pitched or fractional-pitched because coil span is equal to 5/6 of a pole-pitch. It falls short by 1/6 pole-pitch or by 180°/6 = 30°.

$$K_p = \frac{Resultant\ emf\ of\ short\ pitched\ coil}{Resultant\ emf\ of\ full\ pitched\ coil}$$
$$= \frac{Phasor\ sum\ of\ coil\ side\ emfs}{Arithmetic\ sum\ of\ coil\ side\ emfs}$$
$$= \frac{2E\cos\frac{\alpha}{2}}{2E} = \cos\frac{\alpha}{2}$$

Hence, it must be the ratio of phasor sum of induced emfs per coil to the arithmetic sum of induced emfs per coil. Therefore, it must be less than unity.
Short-pitched coils are deliberately used because of their advantages.

Advantages of Short-pitched coils

1. They save copper of end connections.

2. The harmonics in the generated emf are reduced. Hence the generated e.m.f. is sinusoidal.sine wave more easily and the distorting harmonics can be reduced or totally eliminated.

3. Due to elimination of high frequency harmonics, eddy current and hysteresis losses are reduced thereby increasing the efficiency. It also reduces the heating of the core.

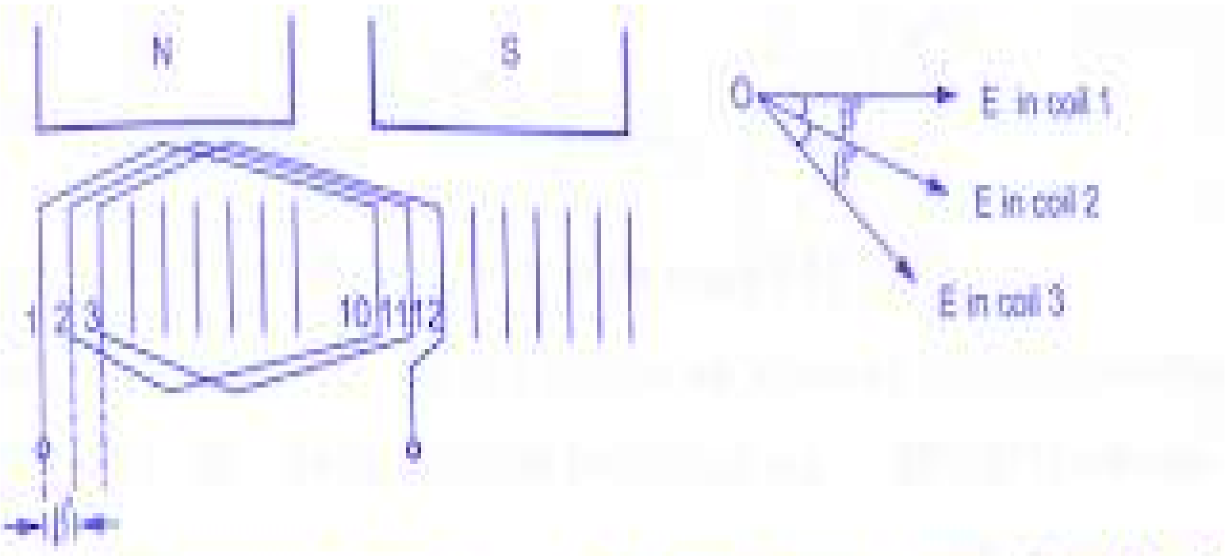
But the disadvantage of using short-pitched coils is that the total voltage around the coils is somewhat reduced. Because the voltages

[Note: Harmonics are voltage components with frequencies other than the fundamental frequency.(i.e. frequency = 2f,3f,4f,5f,7f……)]

Distribution factor or Breadth factor or Winding factor(Kd, Kb,Kw)

In concentrated winding, the coil sides of a given phase are concentrated in a single slot under a given pole and the individual coil voltages induced are in phase with each other. These voltage may be added arithmetically. But in Alternators, in each phase coils are not concentrated in a single slot, but are **distributed** in a number of slots over the entire periphery of the armature to form a polar group under each pole. The voltage induced in coil sides constituting a polar group are not in phase but differ by an angle equal to the angular displacement β of the slots. Hence the total voltage induce in any phase will be the phasor sum of the individual coil voltage.

As per definition, distribution factor is a measure of resultant emf of a distributed winding in compared to a concentrated winding. The factor by which there is a reduction in the e.m.f. due to the distribution of coils is called distribution factor denoted as Kd.



(a) Distributed winding (b) Phase difference between induced e.m.f.

$$Kd = \frac{\text{Resultant emf when coils are distributed}}{\text{Resultant emf when coils are concentrated}}$$

$$Kd = \frac{\text{Phasor sum of coil voltages /phase}}{\text{Arithmetic sum of coil voltages /phase}}$$

$$Kd = \frac{\text{Sin } (m\,\beta/2)}{m\text{Sin } (\beta/2)}$$

where m = No.of slots/pole/phase

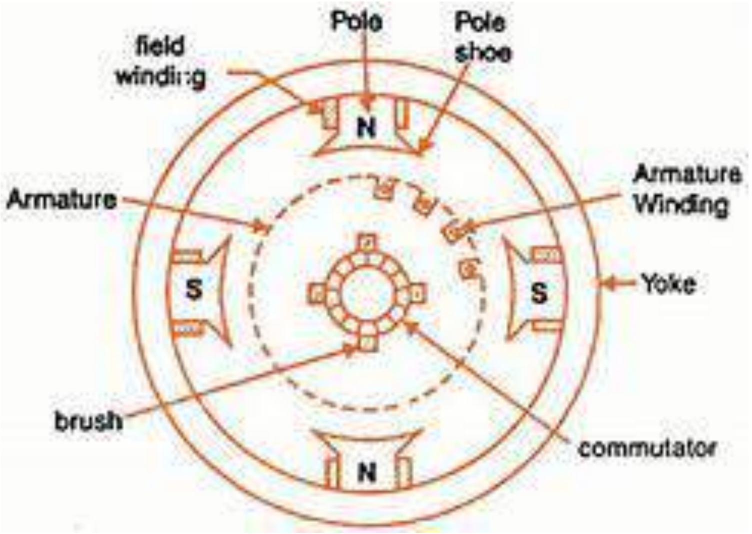
$$m = \frac{\text{slots}}{\text{poles x phases}}$$

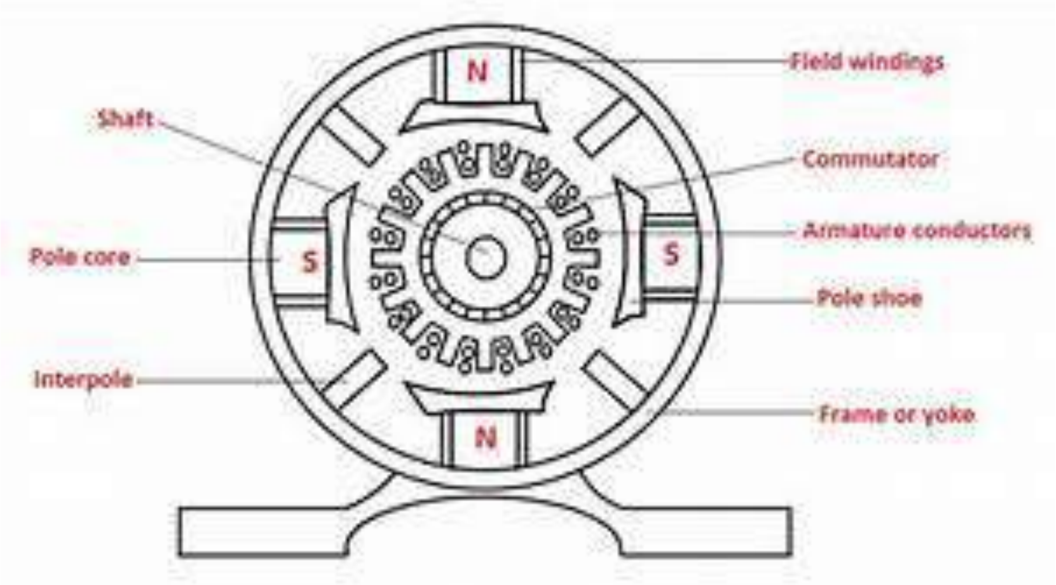
$$= S/ 3P$$

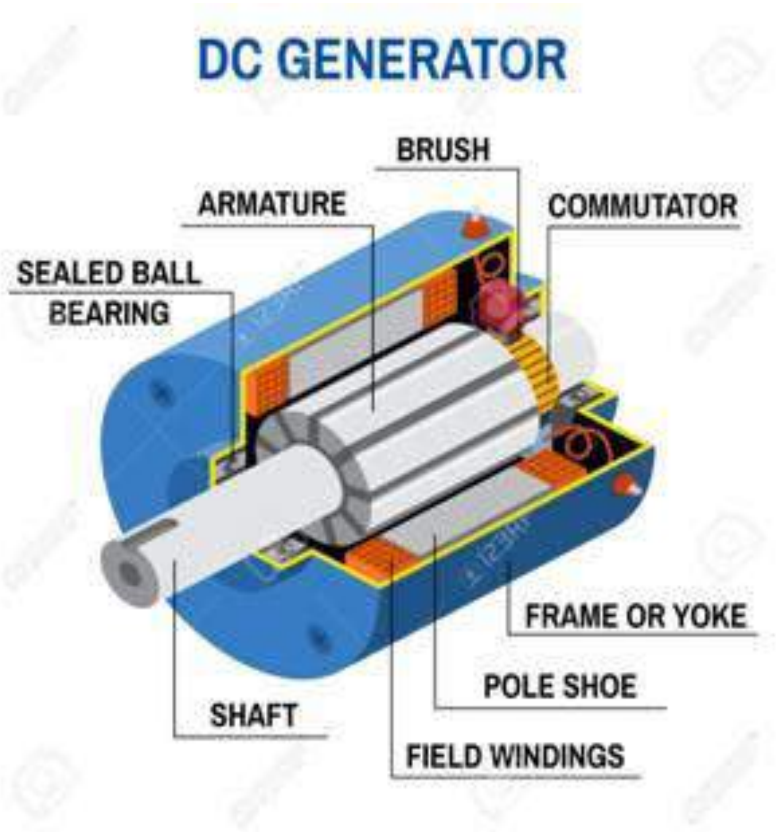
$$\underline{\beta} = \text{Slot angle} = \frac{180}{\text{No.of slots/pole}} = \frac{180\ P}{S}$$

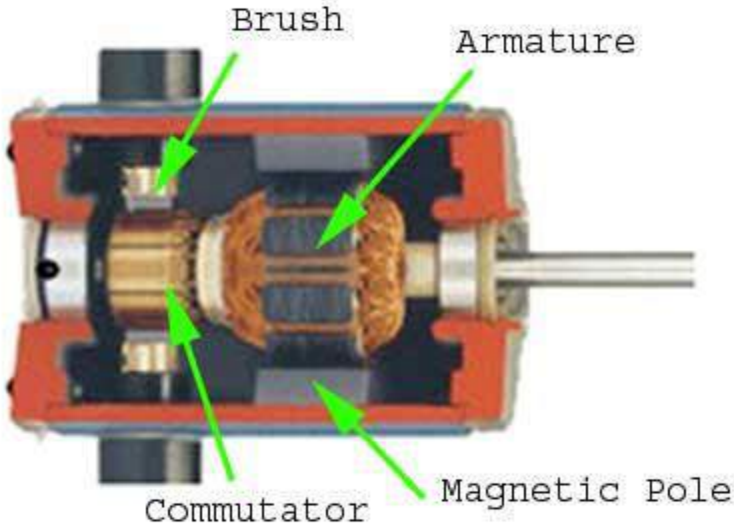
pitch factor, distribution factor are also always less than unity.

DC Generator construction for comparison with alternator

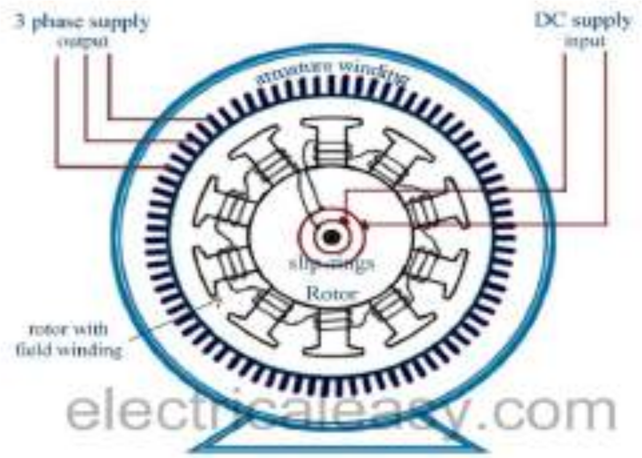


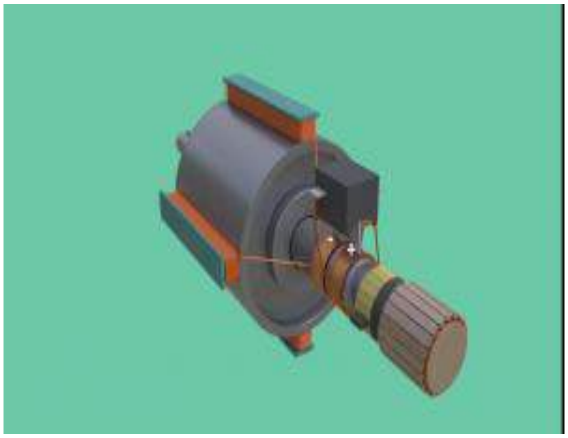


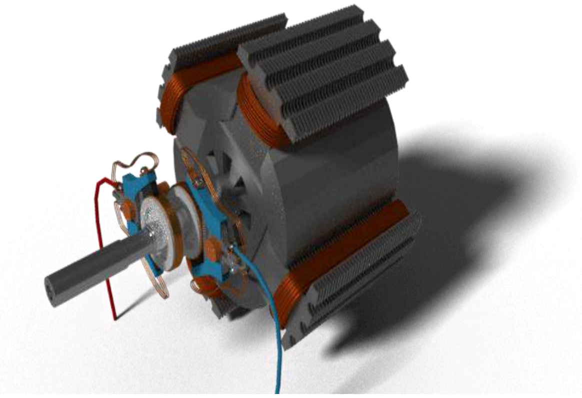

DC GENERATOR
BRUSH
ARMATURE
COMMUTATOR
SEALED BALL BEARING
FRAME OR YOKE
POLE SHOE
SHAFT
FIELD WINDINGS


Brush
Armature
Commutator
Magnetic Pole

Alternator construction showing slip rings







3 PHASE INDUCTION MOTORS

3 PHASE INDUCTION MOTORS ARE the most widely used ac motors. They work on the principle of Induction. The rotor windings are not connected to any AC supply. When the supply is connected to stator winding, the voltage and currents are induced in the rotor conductors due to mutual induction from the stator winding. When a 3 phase supply is given to the stator 3 phase winding, a rotating magnetic field of constant magnitude and rotating at synchronous speed Ns is produced in the airgap. This induces currents in the rotor windings and produce a torque on the rotor due to which starts rotating.

Advantages of 3 PHASE INDUCTION MOTORS

1. It has very simple , robust and unbreakable construction.
2. Its cost is low and highly reliable
3. It has high efficiency.
4. It works with reasonably good p.f. at rated load.
5. Its maintenance is easier.
6. IMs are self-starting. Only Large motors need some starting arrangements.

Disadvantages

It is a constant speed motor and the speed can’t be changed easily.

Its starting torque is less compared to DC motor.

Construction

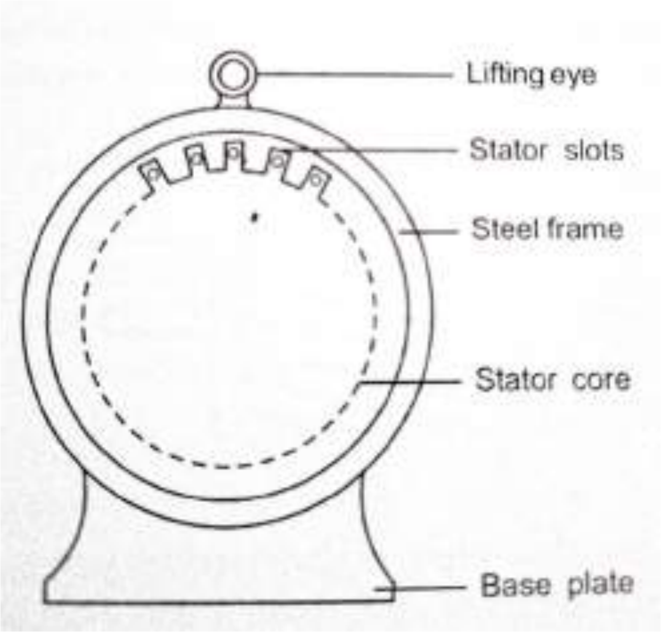
Three phase Induction motors has mainly two parts-

Stator – Stationary part

Rotor – Rotating part

In between the stator and rotor, there is air gap of length 0.4mm to 4mm.

Stator



Stator

Frame - The stator has a cast steel frame which is a cylindrical drum and protects the motor from moisture and other impurities. It is the outer part of the three phase induction motor. Its main function is to support the stator core and the stator winding. Stator core-is in cylindrical in structure & is made up of silicon steel laminations to reduce eddy current loss and hysteresis loss. The thickness of these laminations varies from 0.35mm to 0.65mm. The stampings (laminations) are insulated from each other by a coating of varnish and are held together by bolts. A large number of uniform slots are cut on the inner periphery of the core.

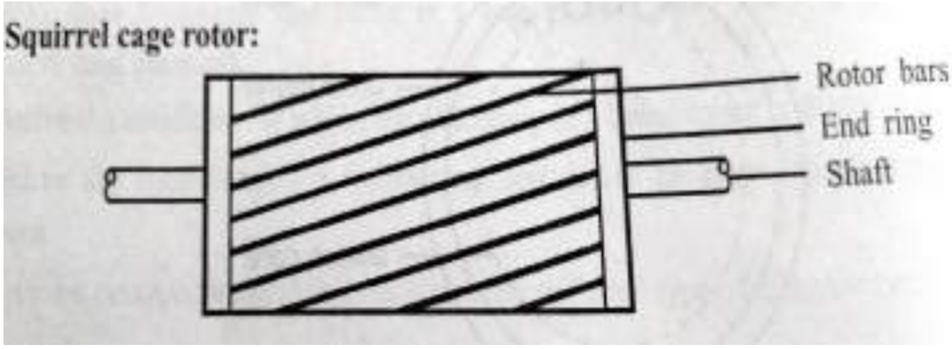
Stator winding - These slots in the core carry stator conductors which are insulated from each other and also from the slots. These conductors are connected as a balanced, double layer three phase windings in star or delta and is fed from three phase supply. Stator windings are wound for definite number of poles based on the requirement of speed. When stator windings are supplied by three phase supply, a rotating magnetic field is produced below the stator in the air gap and this rotating field induces emf in the rotor conductors by mutual induction. The synchronous speed with which the stator magnetic field rotates is given by, Ns = 120 f/P.

Rotor-

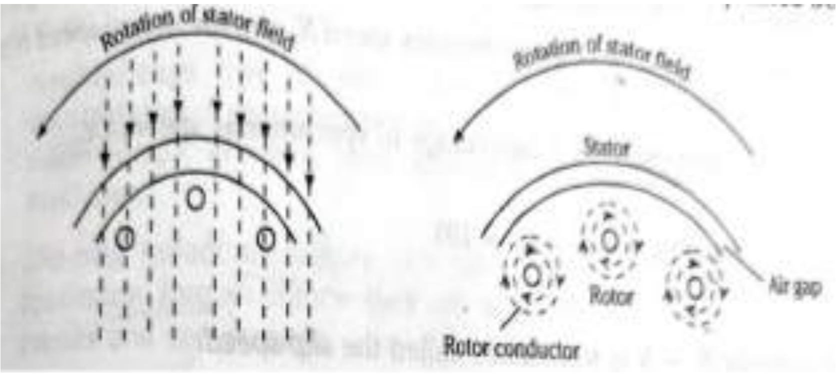
Rotor of three phase induction motor are classified as

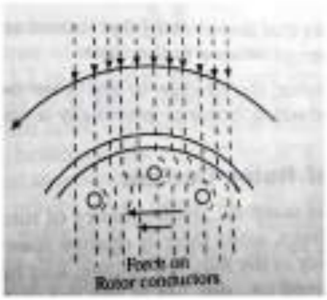
- (i)Squirrel cage rotor
- (ii) Slip ring or Phase wound or Wound rotor
- Squirrel cage rotor

- Squirrel cage rotors are widely (nearly 90%) used because of their simple and rugged construction.
- The rotor consists of hollow laminated core with parallel slots provided on the outer periphery or the surface. The rotor conductors are solid bars of copper, aluminum or their alloys.
- The bars are inserted from the ends into the semi-enclosed slots and are brazed to the thick short circuited.
- Each slot has one bar conductor and all the bars are welded at both ends to copper rings called end rings.
- Hence the copper bars are short circuited at both the ends and it is not possible to add any external resistance in series with the rotor winding.
- The rotor slots are skewed to avoid humming and locking tendency of the rotor with stator. The rotor conductors and their end rings form a completely closed circuit resembling the cage of squirrel and hence the name.



Principle of working





When the stator of 3 phase induction motor is connected to 3 phase AC supply a magnetic field of constant magnitude rotating at synchronous speed is produced in the air gap and cuts the rotor conductors which are stationary. Ns = 120f/P is the synchronous speed.

According to Faraday's laws of electromagnetic induction an EMF is induced in the stationary rotor conductors due to the relative speed between the stator field and the rotor. The frequency of this induced EMF is the same as that of supply frequency and the direction of EMF is obtained by Fleming,s right hand rule .

Since the rotor conductors form a closed circuit, current flows through them whose direction is such as to oppose the very cause producing it according to lenze,s law. The cause producing the rotor current is the relative velocity and the rotor tries to reduce the relative velocity.

Hence the rotor stars running in the same direction as that of stator field to catch up with it but it fails to reach the speed of stator field i.e. synchronous speed Ns. So the rotor always runs with speed less than the synchronous speed Ns. i.e. N < Ns.

If the Rotor becomes successful in reaching the synchronous speed then the relative speed becomes zero. i.e. Ns-N = 0

Then the EMF induced in the rotor conductors becomes zero and current through them also becomes zero. Then the torque on the rotor becomes zero and the rotor tends to stop. Therefore the rotor can never reach the speed of the stator field. And the relative speed can never be zero.

Slip

The rotor of the induction motor can never reach the speed of stator field that is synchronous speed.
The rotor speed N < Synchronous speed Ns
The difference between the synchronous speed of the stator magnetic field Ns and actual speed of the motor N is called the slip speed.
i.e. slip speed = Ns –N

The slip of the induction motor is defined as the ratio of the slip speed and the synchronous speed

$$s = \frac{Ns - N}{Ns}$$

$$\text{And } \%s = \frac{(Ns-N)}{Ns} \times 100$$

Frequency of rotor current

When the rotor is stationary,

the frequency of rotor current = supply frequency f.

When the rotor is rotating,

the frequency of rotor current α relative speed or slip speed

i.e. $f' \alpha N_s - N$

If f' is the frequency of the rotor current

$$N_s - N \; \alpha \; \frac{120 f'}{P} \quad \text{--------(1)}$$

$$N_s = \frac{120f}{P} \quad \text{---------(2)}$$

1 / 2 gives,

$$\frac{N_s - N}{N_s} = \frac{f'}{f} = s$$

$f' = s\,f$

Rotor current frequency = slip x supply frequency

https://www.youtube.com/watch?v=Mle-ZvYi8HA
https://www.youtube.com/watch?v=Mle-ZvYi8HA -cONSTRUCTION
https://www.youtube.com/watch?v=AQqyGNOP_3o - WORKING
https://www.youtube.com/watch?v=QLvWGFD4Qyo&t=8s
https://www.youtube.com/watch?v=QLvWGFD4Qyo&t=8s
https://www.youtube.com/watch?v=Mle-ZvYi8HA