Consolidated Academic Administration Plan for the Course

Analog Communication (core) – Sem. V –

Electronics and Telecommunication Engineering – 2017-2018 – Odd. Semester

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The academic resources available inVIT –

VMIS (ERP)	V-Referand V-Live	VIT Library	VAC & MOOC Courses
Institute & Department Vision and Mission	Former IA question papers and solutions (prepared by faculty)	Former IA question papers solutions - hardcopy	Value Added Courses (VAC) are conducted throughout the semester &in the semester break - Enrol for the VACs
Program Educational Objectives (PEO)	MU end semester examination question papers and solutions (prepared by faculty)	MU end semester exam question paper & solutions - by faculty, hardcopy	
Program Specific Outcome (PSO)	Class notes and Digital Content for the subject (scanned / typed by faculty)	All text books, reference books, e -books mentioned in the syllabus& AAP	Online courses from NPTEL, Coursera etc. are pursued throughout the semester - Register for the course& get certified
Program Outcome (PO)	Comprehensive question bank, EQ, GQ, PPT, Class Test papers	Technical journals and magazines for reference	
Departmental Knowledge Map	Academic Administration Plan & Beyond Syllabus Activity report	VIT library is member of IIT Bombay Library	Watch former lectures captured in LMS at VIT

1.a Course Objectives (write in detail – follow NBA guideline in this regard)

Cognitive	What do you want students to know?	Students should know the basics of Communication systems, types of modulation and demodulation.
Affective	What do you want students to think / care about?	Students should think about analog and digital modulation techniques, different types of Receivers.
Behavioural	What do you want students to be able to do?	Students should be able to develop mini projects related to different modulation techniques, Receivers.

1.b Course Outcome (CO) Statements and Module-Wise Mapping (follow NBA guideline)

Analog Communication

CO No.	Statements	Related Module/s
CO1	Students will be able to identify various types of noise which will be used for analysis of basic communication systems.	1
CO2	Students will be able to analyze, compare and contrast different continuous and Pulse modulation and demodulation techniques used in communication which will be used for various types of applications.	2,3,6
CO3	Students will be able to understand various types of Radio Transmitters and Receivers which will be used for communication.	4
CO4	Students will be able to understand and analyze sampling theorem and sampling techniques which will be used in digital communication.	5

Communication Engineering Laboratory -I

CO No.	Statements	Related Module/s
CO1	Students will be able to analyze performance and calculate modulation index of different analog modulation techniques.	1, 2, 4
CO2	Students will be able to demonstrate sampling theorem and various techniques of sampling and compare various pulse modulation schemes used for data transmission.	5, 6
CO3	Students will be able to experiment multiplexing techniques which will be used for various communication systems.	6
CO4	Students will be able to simulate various modulation techniques using modern tools.	2, 3, 4, 6

1.c Mapping of COs with POs (mark S: Strong, M: Moderate, W: Weak, Dash '–': not mapped)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	S	M	W			W	W					
CO 2	M	S	M	W	M		W					
CO 3	M	S	S	W	M	W	S	W	W	W	M	M
CO 4	M	S	W	W	M							M

1.d Mapping of COs with PSOs (mark S: Strong, M: Moderate, W: Weak, Dash '–':not mapped)

	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	M	S	M	NA
CO 2	S	S	M	NA
CO 3	S	S	M	NA
CO 4	M	S	W	NA

1.e Teaching and Examination Scheme (As specified by the University) for the Course

Categories	Mathematics	Basic Science & General Engg.	Humanities & Soft Skill	Core Engg./Technology - Design & Analysis	Multidisciplinary
Tick suitable category	√	NA	NA	√	NA

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC 502	Analog Communication	04	02	00	04	01	00	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks IA Test			End Sem. Exam Marks	TW	Practical	Oral	Total
		IA 1	IA 2	Average of IA1 and IA2					
ETC 502	Analog Communication	20	20	20	80	NA	NA	NA	100

1.f Faculty-Wise Distribution of all Lecture-Practical-Tutorial Hours for the Course

Divisions	Lecture (Hrs.)	Practical (Hrs.)				Tutorial (Hrs.)			
		Batch 1	Batch 2	Batch 3	Batch 4	Batch 1	Batch 2	Batch 3	Batch 4
A	BRB-04	02-BRB	02-BRB	02-BRB	02-BRB	NA	NA	NA	NA
B	BRB-04	02-HAR	02-HAR	02-HAR	02-PCR	NA	NA	NA	NA
C	HAR-04	02-MKN	02-MKN	02-ASR	02-ASR	NA	NA	NA	NA

1.g Office Hours (Faculty will be available in office in this duration for solving students' query)

Division	Day	Time (at least 1 Hr. / Division)	Venue (Office Room No.)
A	Tuesday	3.45 to 4.45 pm	M-415 (EXTC Staff Room)
B	Wednesday	3.45 to 4.45 pm	M-415 (EXTC Staff Room)
C	Thursday	10.00 to 11.00 am	M-415 (EXTC Staff Room)

2.a Syllabus : Module Wise Teaching Hours and % Weightage in University Question Paper

Module No.	Module Title and Brief Details	Teaching Hrs. for each module	% Weightage in University Question Papers
1	**Basic communication system**: Block diagram, Electromagnetic spectrum, Signal Bandwidth and power, Types of communication channels. Noise in Communication systems, Signal-to-Noise ratio, Noise factor and Noise Figure, Equivalent Noise Temperature	4	8%
2	**2.1 Amplitude modulation and demodulation:** Basic concept , signal representation, need for modulation, spectrum, waveform, modulation index, bandwidth, voltage distribution and power calculation **2.2 DSBFC** Spectrum, waveforms, modulation index, bandwidth, voltage distribution, and power calculation **2.3 DSBFC**: Principles, modulating circuits, low level and high level transmitters.**DSB suppressed carrier**:- Multiplier modulator, nonlinear modulator, and switching modulator, **Single Side Band (SSB):-**Principle, Filter method, phase shift method and third method. Quadrature amplitude modulation (QAM), Independent sideband (ISB) and Vestigial Side Band (VSB) principles and transmitters **2.4 Amplitude demodulation:** Diode detector, practical diode detector, and square law detector. **2.5** Applications of AM and use of VSB in broadcast television	12	23%
3	**Angle Modulation and Demodulation** **3.1 Frequency modulation (FM):** Basic concept, mathematical analysis, frequency spectrum of FM wave, sensitivity, phase deviation and	14	27%

	modulation index, frequency deviation and percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio, narrow Band FM, and Wide Band FM. **3.2** Varactor diode modulator, FET reactance modulator, stabilized reactance modulator-AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle in FM, pre-emphasis and de-emphasis. **3.3 Phase modulation (PM):** Principle and working of Transistor direct PM modulator and relationship and comparison between FM and PM **3.4 FM demodulation:** Balance slope detector, Foster-Seely discriminator, ratio detector, Phase lock loop(PLL) FM demodulator, amplitude limiting and thresholding, comparison between FM demodulators, comparison between AM, FM and PM. **3.5 Applications of FM and PM**		
4	**Radio Receivers** **4.1** TRF, Super-heterodyne receiver, receiver parameters, and choice of IF. **4.2** AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC, and communication receiver **4.3** FM receiver circuits, comparison with AM receiver **4.4** Single and independent sideband (SSB and ISB) receivers	10	19%
5	**Sampling Techniques** **5.1** Theorem for low pass and band pass signals, proof with spectrum, Nyquist criteria **5.2** Sampling techniques, aliasing error, and aperture effect	4	8%
6	**Pulse Modulation and Demodulation** **6.1** PAM, PWM, PPM generation and detection **6.2** Delta modulation, adaptive delta modulation, principle, generation and detection **6.3** TDM and FDM basic concepts and block diagram **6.4** Applications of pulse communication	8	15%
Total		**52**	**100%**

2.b Prerequisite Courses

No.	Semester	Name of the Course	Topic/s
1	III	Analog Electronics-I	Basic working of Transistor and FET
2	IV	Signals and systems	Fourier Transform

2.c Relevance to Future Courses

No.	Semester	Name of the Course
1	VI	Digital Communication
2	VI	HDTV
3	VII	MCS

2.d Real Life Application Mapping – Mention Application from Very Common Day to Day Life

No.	Real Life Application Mapping with the Course
1	AM and FM Transmission
2	Digital Communication systems
3	Television Systems

3. Past Results – Division-Wise and Topic-Wise Result Based Analysis

Details	Target - Dec 2017	Dec 2016	Dec 2015	Dec 2014
Course Passing % – Average of 3 Divisions	100%	97.66%	97.54%	93.52%
Marks Obtained by Course Topper (mark/100)	95	94	92	91

	Division A		Division B		Division C	
Year	Initials of Teacher	% Result	Initials of Teacher	% Result	Initials of Teacher	% Result
Dec 2016	BRB	96.3%	BRB	98.61%	PCR	100%
Dec 2015	BRB	98.66%	ANJ	97.10	ANJ	96.11%
Dec 2014	BRB	94.52%	SMP	89.85%	BRB	96.5%

Topics which affect results negatively	Module Number	Recommendations to overcome these issues & improve result in future
Proof of Sampling theorem	5	Basics of Fourier Transforms to be revised.

4 All the Learning Resources – Books and E-Resources

4.a List of Text Books (T – Symbol for Text Books) to be Referred by Students

Sr. No	Text Book Titles	Author/s	Publisher	Edition	Module Nos.
1	Electronics Communication System	Kennedy and Davis	Tata McGraw Hill	Fifth edition	1, 2
2	Electronic Communication Systems	Wayne Tomasi	Pearson Education	Fifth edition	1, 2, 3, 4
3	Electronic Communication	Dennis Roddy and John Coolen	Prentice Hall	Third Edition	1,2,3,4

4.b List of Text Books (R – Symbol for Reference Books) to be Referred by Students

Sr. No	Reference Book Titles	Author/s	Publisher	Edition	Module Nos.
1	Modern Digital and Analog Communication system	B.P. Lathi, Zhi Ding	Oxford University Press	Fourth edition	1,2
2	Principles of Communication Systems	Herbert Taub and Donald Schilling	Tata McGraw-Hill	Third edition	1,2,3,5,6
3	Communication Systems: Analog and Digital	P. Sing and S.D. Sapre	Tata McGraw Hill	Third edition	1,2,3,6
4	Introduction to Analog and Digital Communication	Simon Haykin, Michel Moher	Wiley	Second edition	5,6

4.c List of E - Books (E – Symbol for E-Books) to be Referred by Students

Sr. No	E- Book Titles	Author/s	Publisher	Edition	Module Nos.
1	Introduction to Analog and digital communications (http://moodle.najah.edu/pluginfile.php/104907/mod_resource/content/1/An%20Introduction%20to%20Analog%20and%20Digital%20Communications%2C%202nd%20Edition%20by%20Simon%20Haykin.pdf)	Simon Haykin, Michael Moher	John Wiley & Sons, Inc	Second	1,2,3,4,5,6
2	Communication systems Engineering (http://www.ee.iitm.ac.in/~giri/pdfs/EE4140/textbook.pdf)	John Proakis, Masoud Salehi	Pearson Education International	Second	1,2,3,6
3	Analog Communication (https://www.smartzworld.com/notes/analog-communication-system-ac/)	JNTU	Smartzworld	First	1,2,3,4,6
4	Analog Communication (https://www.tutorialspoint.com/analog_communication/analog_communication_tutorial.pdf)	Tutorials Point	Tutorials Point	First	1,2,3,4,5,6

4.d Web Links and Names of Magazines, Journals, E-journals– [VIT is member of IIT Bombay Library]

Refer online journals subscribed in VIT library. You can also access IIT Bombay online library for journals from IITB campus.

Sr. No.	Web-Links and Names of Journals and E-Journals Recommended to Students for this Course	Web-Links and Names of Magazines Recommended to Students for this Course	Module Nos.
1	International journal on communication systems-wiley online library http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1131/issues	1.Electronics for You www.efymagonline.com/	2,3, 4,6
2	IEEE Communications Surveys & Tutorials http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=9739	2.Elector magazine https://www.elektor.com/magazines/	3,4
3	International journal of analog and digital communication onlinelibrary.wiley.com/doi/10.1002/dac.v3:2/issuetoc	IEEE Communications magazine	4,6

		http://www.comsoc.org/commag/	
4	IEEE Spectrum : spectrum.ieee.org/	Digital communication magazine technav.ieee.org/tag/2758/digital-communication	6

4.e **Module Best Available in - Tick the best resource [from *4.a* to *4.d* in this AAP] & give details**

Module No.	Category (Please Tick Mark) - √						Available In VIT Library?		Details of the Resource (i.e. Name, Chapter & Page No., etc.)
	Book			Maga-zine	Journals				
	Text	Reference	E-Book		Regular	E-Journal	Y	N	
1	√						Y		Electronics Communication System By, Kennedy and Davis of Tata McGraw Hill, 5th Edition. Chapter 1: Introduction to Comm. Systems, Pg. No: 1 to 14 Chapter 2: Noise, Pg. No: 15 to 32
2	√						Y		Electronics Communication System By, Kennedy and Davis of Tata McGraw Hill, 5th Edition. Chapter 3: Amplitude modulation Techniques, Pg. No: 33 to 66 Chapter 7: Radio Transmitters and Receivers (For AM Demodulators) , Pg. No: 161 to 164
3	√						Y		Electronics Communication System By, Kennedy and Davis of Tata McGraw Hill, 5th Edition. Chapter 4: Angle modulation Techniques, Pg. No: 67 to 103 Electronic Communication Systems By Wayne Tomasi of Pearson Education Fifth edition. Chapter 7: Angle Modulation Transmission (For FM Modulator) Pg. No: 273 to 294 Chapter 8: Angle Modulation reception and FMs Stereo(For FM Demodulators) Pg. No: 295 to 310
4	√						Y		Electronics Communication System By, Kennedy and Davis of Tata McGraw Hill, 5th Edition. Chapter 7: Radio Transmitters and Receivers, Pg. No: 140 to 186

									Electronic Communication Systems By Wayne Tomasi of Pearson Education Fifth edition. Chapter 8: Angle Modulation reception and FMs Stereo Pg. No: 295 to 330
5		√					Y		Introduction to Analog and Digital Communication by Simon Haykin, Michel Moher of Wiley Second edition Chapter 4: Sampling Process, Pg. No: 134 to 154
6	√						Y		Electronics Communication System By, Kennedy and Davis of Tata McGraw Hill, 5th Edition. Chapter 5: Pulse Modulation Techniques, Pg. No: 104 to 115 Electronic Communication Systems By Wayne Tomasi of Pearson Education Fifth edition. Chapter 11: Digital T- Carriers and Multiplexing Pg. No: 431 to 442

4.f Web Links for Online Notes/YouTube/VIT Digital Content/VIT Lecture Capture/NPTEL Videos

No.	Websites / Links	Module Nos.
1	NPTEL series: Analog Communication by Prof. Surendra Prasad, Department of Electrical Engineering ,IIT Delhi https://www.youtube.com/watch?v=TPm0XSPxld8	1,2,3,4,5,6
2	https://www.youtube.com/watch?v=G9Ue8Edx7TQ	1
3	https://www.youtube.com/watch?v=WcTMbJ1rSHI	1
4	https://www.youtube.com/watch?v=fGf_ng7qljI	2
5	https://www.youtube.com/watch?v=UwGNDIlhWj8	2
6	https://www.youtube.com/watch?v=-ccrXpAJgjs	2
7	https://www.youtube.com/watch?v=4nyNJXEVB-o	2
8	https://www.youtube.com/watch?v=e_gTCU2fnD8	2
9	https://www.youtube.com/watch?v=QEubAxBfqKU	2,3
10	https://www.youtube.com/watch?v=X9geo28ST7g	3
11	https://www.youtube.com/watch?v=X9geo28ST7g	3

12	https://www.youtube.com/watch?v=AQf7Xwu--ZM	3
13	https://www.youtube.com/watch?v=G5_zuI5wrTY	3
14	https://www.youtube.com/watch?v=dTEOVD0eBsM	3
15	https://www.youtube.com/watch?v=kaNXLwfg_RA	4
16	https://www.youtube.com/watch?v=-Yr3CvrRQyw	4
17	https://www.youtube.com/watch?v=vbjC-aCmMUM	5
18	https://www.youtube.com/watch?v=vJ8V8ipSZ50	5
19	https://www.youtube.com/watch?v=TM47sEXeaj8	6
20	https://www.youtube.com/watch?v=h8GamclaTEM	6

4.g Recommended MOOC Courses like Coursera / NPTEL / MIT-OCW / edX etc.

Sr. No.	MOOC Course Link	Course conducted by – Person / University / Institute / Industry	Course Duration	Certificate (Y / N)
1	https://www.openlearning.com/courses/principles-of-communication-engineering	Open Learning	Self Paced	Y
2.	https://onlinecourses.nptel.ac.in/noc17_ec11/preview	NPTEL, Prof. Goutam Das, IITKGP	July 24,2017 - October 13,2017)(12 Weeks)	Y(On registering for exams)
3	https://swayam.gov.in	SWAYAM, Prof. Goutam Das, IITKGP	JULY-OCT 2017	Y

4.h Recommended Value Added Courses (VAC)

Sr. No.	Name of the Value Added Course	Conducted by – Person / Institute / Industry	Course Duration	Certificate (Y / N)
1	Fundamentals of Radio communication and Receivers	AIR,Malad	3 weeks	Y

4.i Study Material to be Distributed among Students

Tick if distributed among students					
GQ	Notes	Digital Content	PPT	EQ (updated till the Last Exam)	Other (Write Details)
√	√	√	√	√	Paper Solutions

5. Consolidated Course Lesson Plan

	From (date/month/year)	To (date/month/year)	Total Number of Weeks
Semester Duration	10/07/2017		14

Week	Lecture no.	Module No.	Lecture Topics / IA 1 and IA 2 / BSA planned to be covered	Actual date of Completion	COs	Recommended Prior Viewing / Reading	
						Lecture No. (on LMS)	Chapter No. / Page Nos./ Books/ Web Site
1	1 to 2	NA	**Academic Administration** – Constituents of Study, Scheme of Marking / Grading and Assessment.		NA	NA	NA
	3 to 4	1	**Basic communication system**: Block diagram, Electromagnetic spectrum, Signal Bandwidth and power, Types of communication channels, Noise in Communication systems,		CO1	NA	**T1: Chapter 1:** Pg. 1 to 12 **Chapter 2:** Pg. 16 to 20 https://www.youtube.com/watch?v=G9Ue8Edx7TQ
2	5 to 6	1	Signal-to-Noise ratio, Noise factor and Noise Figure, Friiss Formula for Noise factor, Equivalent Noise Temperature ,Problems		CO1	NA	**T1: Chapter 2 :** Pg. 20 to 28 https://www.youtube.com/watch?v=WcTMbJ1rSHI
	7 to 8	2	**Amplitude modulation and demodulation:** Basic concept, signal representation, need for modulation, modulation, spectrum, waveform, modulation index, bandwidth, voltage distribution and power calculation		CO2	NA	**T1: Chapter 3 :** Pg. 33 to 37 https://www.youtube.com/watch?v=fGf_ng7qljI
3	9 to 10	2	2.2 DSBFC Spectrum, waveforms, modulation index, bandwidth, voltage distribution, and power calculation.		CO2	NA	**T1: Chapter 3 :** Pg. 38 to 41 https://www.youtube.com/watch?v=UwGNDIlhWj8

	11 to 12	2	2.3 DSBFC: Principles, modulating circuits, low level and high level transmitters.		CO2	NA	**T1: Chapter 3 :** Pg. 52 to 61 https://www.youtube.com/watch?v=QEubAxBfqKU
4	13 to 14	2	DSB suppressed carrier:- Multiplier modulator, nonlinear modulator, and switching modulator		CO2	NA	**T1: Chapter 3 :** Pg. 42 to & 55 to 59
	15 to 16	2	Single Side Band (SSB):-Principle, Filter method, phase shift method and third method		CO2	NA	**T1: Chapter 3 :** Pg. 45 to 49 https://www.youtube.com/watch?v=-ccrXpAJgjs
5	17 to 18	2	Quadrature amplitude modulation (QAM), Independent sideband (ISB) and Vestigial Side Band (VSB) principles and transmitters		CO2	NA	**T1: Chapter 3 :** Pg. 49 to 52 https://www.youtube.com/watch?v=4nyNJXEVB-o
	19 to 20	2	2.4 Amplitude demodulation: Diode detector, practical diode detector, and square law detector. 2.5 Applications of AM and use of VSB in broadcast television		CO2	NA	**T1: Chapter 7 :** Pg. 161 to 164 https://www.youtube.com/watch?v=e_gTCU2fnD8
6			IA TEST 1			NA	
			OPEN BOOK TEST			NA	
7	21 to 22	3	**Angle Modulation and Demodulation** 3.1 Frequency modulation (FM): Basic concept, mathematical analysis, frequency spectrum of FM wave, sensitivity		CO2	NA	**T1: Chapter 4 :** Pg. 67 to 71 https://www.youtube.com/wat

			TAKE HOME TEST				ch?v=X9geo28ST7g
	23 to 24	3	phase deviation and modulation index, frequency deviation and percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio		CO2	NA	**T1: Chapter 4 :** Pg. 75 to 78 https://www.youtube.com/watch?v=X9geo28ST7g
8	25 to 26	3	narrow Band FM, and Wide Band FM. 3.2 Varactor diode modulator, FET reactance modulator, stabilized reactance modulator-AFC, Direct FM transmitter, indirect FM Transmitter,		CO2	NA	**T1: Chapter 4 :** Pg. 79, Pg. 86 to 97 **T2: Chapter 7 :** Pg. 273 to 278 https://www.youtube.com/watch?v=dTEOVD0eBsM
	27 to 28	3	noise triangle in FM, pre-emphasis and de-emphasis. **NPTEL VIDEOS**		CO2	NA	**T1: Chapter 4 :** Pg. 80 to 83 https://www.youtube.com/watch?v=AQf7Xwu--ZM
9	29 to 30	3	3.3 Phase modulation (PM): Principle and working of Transistor direct PM modulator and relationship and comparison between FM and PM		CO2	NA	**T1: Chapter 4 :** Pg. 72 to 74 https://www.youtube.com/watch?v=dTEOVD0eBsM
	31 to 32	3	3.4 FM demodulation: Balance slope detector, Foster-Seely discriminator, ratio detector, Phase lock loop(PLL)		CO2	NA	**T1: Chapter 7 :** Pg. 165 to 177
10	33 to 34	3	FM demodulator, amplitude limiting and thresholding, comparison between FM demodulators, comparison between AM, FM and PM. 3.5 Applications of FM and PM **(Students Presentation)**		CO2	NA	**T1: Chapter 4 :** Pg. 166 to 168 https://www.youtube.com/wat

							ch?v=G5_zul5wrTY
	35 to 36	4	**Radio Receivers** 4.1 TRF, Super-heterodyne receiver, receiver parameters, and choice of IF. **(Students Presentation)**		CO3	NA	**T1: Chapter 7 :** Pg. 146 to 161 **T2:Chapter 8 :** Pg. 296 to 298 https://www.youtube.com/watch?v=kaNXLwfg_RA
11	37 to 38	4	4.2 AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC **(Students Presentation)** **TECHNICAL CROSSWORD SOLUTION**		CO3	NA	**T1: Chapter 7 :** Pg. 161 to 164 https://www.youtube.com/watch?v=Xqiyvv2Maf0
	39 to 40		communication receiver		CO1 CO2 CO3 CO4	NA	**Internet**
12	41 to 42	4	4.3 FM receiver circuits, comparison with AM receiver 4.4 Single and independent sideband (SSB and ISB) receivers **(Students Presentation)**		CO3	NA	**T1: Chapter 7 :** Pg. 177 to 181 https://www.youtube.com/watch?v=mEt0SRG0-Nw
	43 to 44	5	**Sampling Techniques** 5.1 Theorem for low pass and band pass signals, proof with spectrum, Nyquist criteria **(Students Presentation)**		CO4	NA	**R4: Chapter 4 :** Pg. 134 to 160 https://www.youtube.com/watch?v=vbjC-aCmMUM
13	45 to 46	5	5.2 Sampling techniques, aliasing error, and aperture effect **(Students Presentation)**		CO4	NA	**R4: Chapter 4 :** Pg. 146 to

							148 https://www.youtube.com/watch?v=vJ8V8ipSZ50
	47 to 48	6	**Pulse Modulation and Demodulation** 6.1 PAM, PWM, PPM generation and detection 6.2 Delta modulation, adaptive delta modulation, principle, generation and detection **(Students Presentation)**		CO4	NA	**T1: Chapter 5 :** Pg. 104 to 113 https://www.youtube.com/watch?v=TM47sEXeaj8
14	49 to 50		Guest Lecture		CO1 CO2 CO3 CO4	NA	
	51 to 52	6	6.3 TDM and FDM basic concepts and block diagram 6.4 Applications of pulse communication		CO2	NA	**T2: Chapter 11:** Pg. 431 to 442 https://www.youtube.com/watch?v=h8GamclaTEM **T2: Chapter 11:** Pg. 442
	53 54		**Pop Quiz –** Based on entire syllabus of Analog communication(AC) University paper solutions		CO1 CO2 CO3 CO4	NA	

6. Assignments / Tutorials Details (must attach print out of all questions together with AAP)

Assignment No.	Title of the Assignments / Tutorials	CO Map	Assignments given to Students on	Date of Submission
1	Handwritten Assignment : Basic communication system	CO1	24/07/17	31/07/17
2	Take home test(THT) : Problems on Noise, Modulation	CO1, CO2	22/08/17	23/08/17
3	Students Presentation	CO1, CO2, CO3, CO4	12/09/17 to 04/10/17	12/09/17 to 04/10/17
4	Pop Quiz/ Technical Crossword	CO1, CO2, CO3, CO4	16/10/17	16/10/17

Analysis of Assignment / Tutorial Questions and Related Resources

Assignment No.	Week No.	Type* (√)			Module No.	Based on #			Question Type (√)	
		R	UQ	OBT		Text Book	Reference Book	Other Learning Resource	MU EQ	Thought Provoking
1	3	√	-	-	1	T1	-	-	√	-
2	7	√	-	-	1,2,3	T1, T2	-	-	√	√
3	10	-	√	-	1, 2, 3, 4 ,5, 6	T1, T2	R4	-	-	√
4	15	-	√	-	1, 2, 3, 4 ,5, 6	T1, T2	R4	-	√	√

7. Internal Assessment / Other Class Test / Open Book Test (OBT)/Take Home Test (THT)Details

Tests	IA Dates	Module No.	CO Map	IA Question Paper Pattern	Policy
1st IA Test	16/08/2017	1, 2, 3	CO1, CO2	Q1 – One line questions - 10 Marks Q2 – 1 Theory or numerical 5 Marks Q3 – 1 Theory or numerical 5 Marks 20 marks each for IA 1 & 2	No IA Re-test IA is a Head of passing *
2nd IA Test	Last week	4, 5, 6	CO2, CO3, CO4		
Class test1,(OBT)	09/08/2017	1, 2, 3	CO1, CO2	Class test 1 based on IA1 syllabus	No Re-test
Class test2	03/10/2017	4, 5, 6	CO2, CO3, CO4	Class test 2 based on IA2 syllabus	No Re-test

*** IA failures will have to appear for re-test in next semester**

8.a Practical Activities – Regular Experiments

Practical No.	Module No.	Title of the **Regular Experiment**	Concepts to be highlighted	CO Map	Audit / Quality Rate (0 to 4)
1	2	Analysis of Amplitude Modulation and Demodulation and Calculation of Modulation Index.	Amplitude Modulation and Demodulation	CO1	4
2	3	Study of Frequency Modulation & Demodulation.	Frequency Modulation & Demodulation	CO1	4
3	5	Analysis of Signal Sampling and reconstruction	Sampling and reconstruction	CO2	4
4	6	Study and analysis of Pulse Modulation (a) Pulse Amplitude Modulation & Demodulation (b) Pulse Width Modulation & Demodulation (c) Pulse Position Modulation & Demodulation	PAM, PPM, PWM	CO2	4
5	3	Design of Preemphasis and Deemphasis circuit in FM	Preemphasis and Deemphasis	CO1	4
6	3, 4	Capture of Live FM signal and display of live FM Channels	Frequency Modulation	CO1	4
7	6	Study of Time Divison Multiplexing and Demultiplexing	Time Divison Multiplexing	CO3	3
8	2, 3	A. Simulation of Amplitude Modulation and Demodulation using MATLAB. B. Simulation of Frequency Modulation and Demodulation using MATLAB.	Amplitude Modulation	CO1, CO4	4

8.b Practical Activities – Newly Added Experiments

Practical No.	Module No.	Title of the **Newly Added Experiments**	Concepts to be highlighted	CO Map	Audit / Quality Rate (0 to 4)
1	2	To generate amplitude modulation using Transistor BC-547 and calculate modulation index for different amplitude of modulating signal	Amplitude modulation	CO1	4
2	3	To perform frequency modulation and demodulation using Octave	Frequency Modulation	CO1	4

8.c Practical Activities – PBL Experiments

Practical No.	Module No.	Title of the **PBL Experiments**	Concepts to be highlighted	CO Map	Audit / Quality (0 to 4)
1	6	Design a circuit to generate Pulse width modulation using Op-Amp and comment on the output obtained	Pulse width modulation	CO2	4

9. Rubric for Grading and Marking of Term Work (inform students at the beginning of semester)

Lecture + Practical (% Attendance) & Marks	Assign-ments	Lab / Practical Performance	Lab Journal Assessment	Class Tests (Other than IA)	Tutorial	Other (1) specify	Other (2) specify	Total
5 Marks	5 Marks	5 Marks	5 Marks	5 Marks	NA	NA	NA	25 Marks (CE-I)

10. Beyond Syllabus Activities for Gap Mitigation

No.	Type of the Activity	Activities	Details
1	Interaction with Outside World	Guest Lecture / Workshops	Guest Lecture by Mr. Kulkarni, Worli, Doordarshan on topic On Practical aspects of Analog communication
2		Industrial Visit	NA
3	Test and Assessments	Class Tests – (other than IA)	Class test based on syllabus for IA 1 in 4th week Class test based on syllabus for IA 2 in 14th week
4		Mini Projects	NA
5		Pop Quiz	Pop quiz based on entire syllabus in 15th week
6		Mobile App Based Quiz	To be conducted based on module 2,3,4
7	Collaborative and Group Activity	Poster Presentation	Poster presentation under lab activity in 3rd week
8		Minute Papers	It will be given at the start of few lectures to get insights of understanding of students
9		Students Seminar	Students Seminar on beyond syllabus topics in a group of 5 students per topic to be conducted from 10th to 13th week
10		Students Debates	NA
11		Panel Discussion / Mock GD	NA
12		Mock Interview	NA
13		Technical Crossword	Technical Crossword in 13th week based on entire syllabus
14	Co-curricular Courses	MOOC-NPTEL/Coursera Videos	NPTEL series: Analog Communication by Prof. Surendra Prasad, Department of Electrical Engineering ,IIT Delhi https://www.youtube.com/watch?v=TPm0XSPxld8
15		Value Added Courses	Fundamentals of Radio communication and Receivers by AIR,Malad
16		Lecture Capture Usage	NA

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Faculty 1

Prof. Harshada A. Rajale
Faculty 2

Mr Abhijeet Dharmadhikari
AGM. Vodafone India Ltd.
External Industry Mentor

Prof. Deepak Karia
Professor,SPIT
External Academic Mentor

Prof. Pranita Padhye
VIT Cluster Mentor Name

Dr. Saurabh Mehta
Head Electronics and Telecommunication Engineering Dept

Total Marks of Question no.		Examiner	
		Moderator	
		ReAssessor	

Space for Marks	Question No.	START WRITING HERE

Solution of IA-2

Subject :- Analog Communication (AC)

Year & Sem :- TE, Sem V

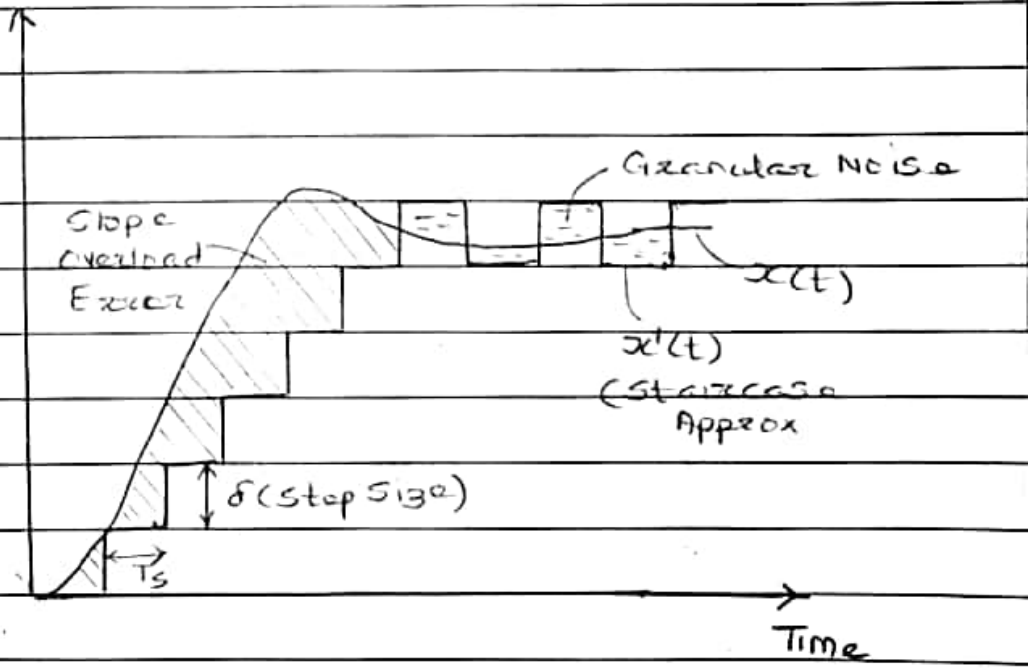
Branch :- Electronics & Telecomm (EXTC)

Date of Test :- 07/10/2017

Prepared By :- Beena. R. Ballal

Q1(a) What are the various disadvantages of Delta Modulation.

Disadvantages of delta Modulation are Slope Overload Distortion and Granular Noise



Slope overload Distortion.

If the slope of analog signal x(t) is much higher than that of x'(t) over a long duration than x'(t)

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Question No. | START WRITING HERE

will not be able to follow $x(t)$ at all. The difference between $x(t)$ and $x'(t)$ is called Slope overload distortion. This error occurs when slope of $x(t)$ is much larger than slope of $x'(t)$

(ii) Granular Noise

When the input signal $x(t)$ is relatively constant in amplitude, the approximated signal $x'(t)$ will hunt above and below $x(t)$ as shown in Fig. It increases with increase in step size δ. To reduce granular noise, step size should be as small as possible.

3·1(b) Give the practical values of AM and FM broadcasting ranges. State their IF frequency values

AM Range: 535 KHz – 1640 KHz

FM Range 88 – 108 MHz

AM IF Frequency :- 455 KHz

FM IF Frequency :- 10.7 MHz

3·1(c) Define Selectivity, Sensitivity, Fidelity and image frequency rejection related to radio receivers

Selectivity =

Selectivity of the Receiver is defined as ability to reject adjacent (unwanted) signals

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Total Marks of Question no.		Examiner	
		Moderator	
		ReAssessor	

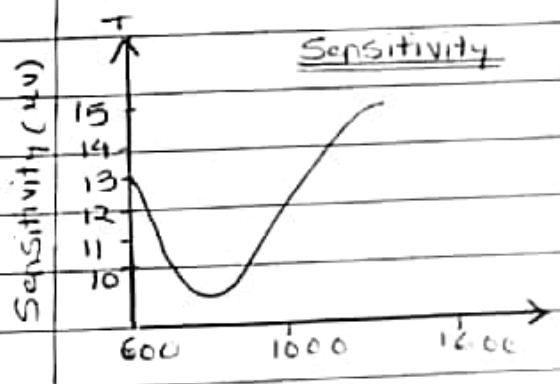
Space for Marks	Question No.	START WRITING HERE

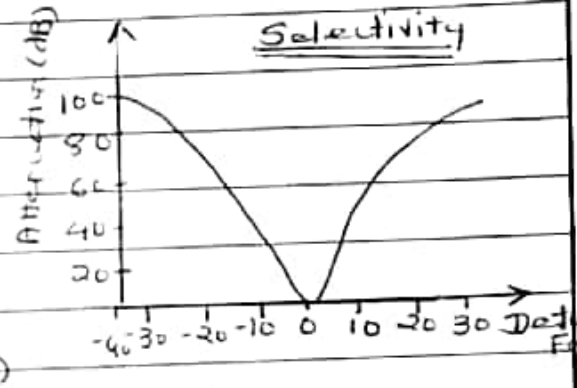
Sensitivity

Sensitivity of Radio Receiver is defined as ability to amplify weak signals. It is often defined in terms of voltage that must be applied to receiver input terminals to give standard output power. It is often expressed in μV or in decibels below 1V.

Fidelity

It is ability of receiver to reproduce correctly all the modulating frequencies equally. High fidelity is required to produce good quality music faithfully





Q.1(d) Difference between TDM and FDM

	TDM	FDM
1.	Signals to be multiplexed takes full BW but are separated in time domain	Signals to be multiplexed are added in time domain but they occupy diff slots in freq domain
2.	Synchronization is req b/w Transmitter & Receiver	Synchronization is not required b/w Transmitter & Receiver
3.	It's ckt not very complex	Requires complex circuitry
4	Due to Fading few TDM channels are affected	Due to fading all FDM ch's are affected

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ReAssessor

Space for Marks	Question No.	START WRITING HERE

Q1(e) List different types of Sampling Techniques

(1) Ideal Sampling.

(2) Practical Sampling (i) Flat top Sampling.

(ii) Natural Sampling or Chopper Sampling.

Q1(f) State Nyquist Sampling Theorem. What is Aliasing Error.

A continuous time signal $x(t)$ can be completely represented in its sampled form and recovered back from sampled form if Sampling frequency f_s is greater than or equal to twice Maximum frequency of continuous time signal $x(t)$.

$$f_s \geq 2W$$

Aliasing Error:

If signal $x(t)$ is not strictly bandlimited and if Sampling theorem is not satisfied i.e. $f_s < 2W$ then error called Aliasing or foldover error occurs. In this high frequency in the spectrum of original signal $x(t)$ taking on the identity of lower frequency in the spectrum of sampled signal

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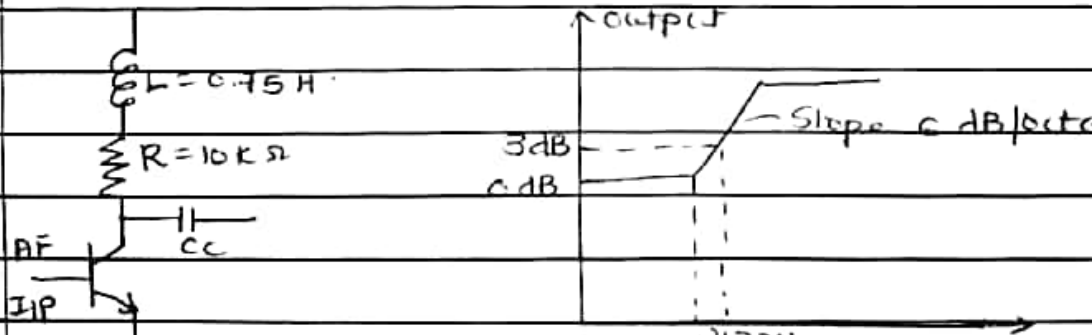
9) Explain Pre-emphasis and De-emphasis used in FM.

Noise Triangle showed that noise has a greater effect on higher modulating frequency than on the lower frequency. Thus if higher frequencies were artificially boosted at the transmitter and correspondingly cut at the receiver an improvement in noise immunity can be obtained.

The boosting of higher modulating frequency in accordance with pre-arranged curve is termed as pre-emphasis. It is carried out prior to FM modulation process. It is basically a High pass Filter.

De-emphasis circuit is the one in which artificially boosted high frequency signals are brought back to their Original amplitude. Here signals are de-boosted so that they are back to original signal.



Pre-emphasis

De-emphasis is a low pass Filter and is performed after FM Demodulation at the Receiver of Fm.

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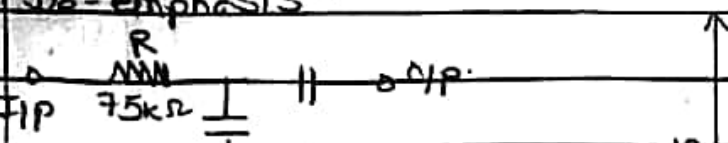
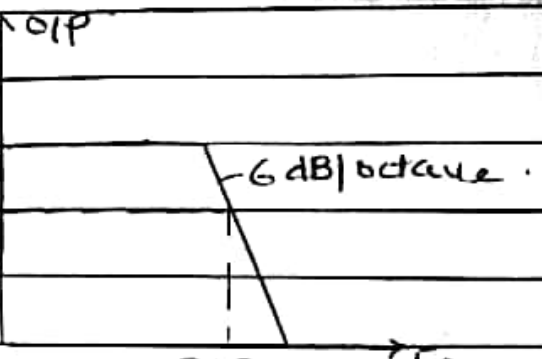
De-emphasis:



(i) Circuit.



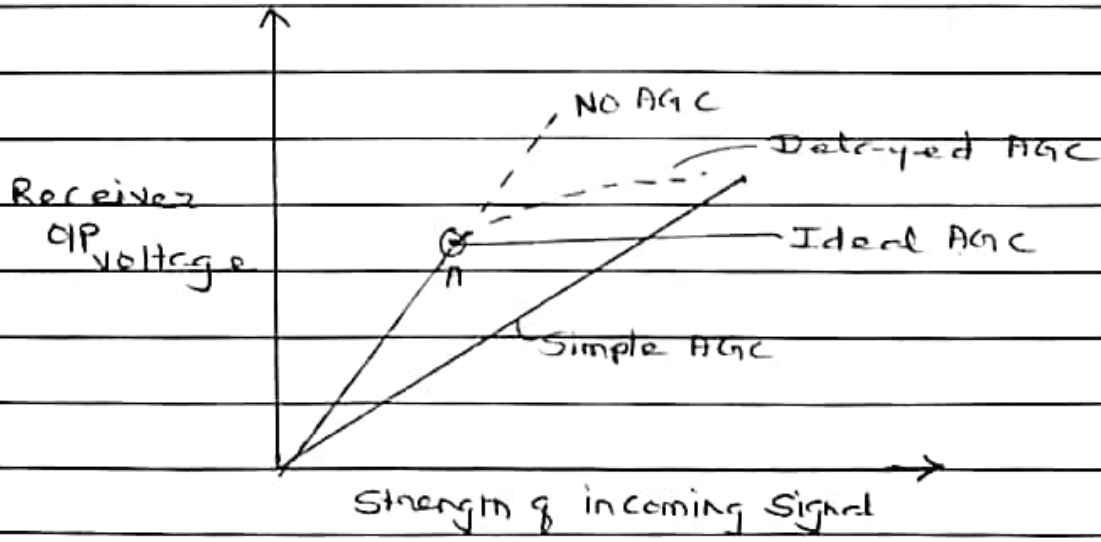
(ii) Curve.

Q. (b) What is AGC? What are different types of AGC. Show them with the help of graph

Signals from various radio stations reaching at the receiver input are not of same strength. AGC which is automatic Gain control is used to adjust the gain of the receiver automatically to keep receiver output constant irrespective of strength of input signal.

Types of AGC

(i) Simple AGC (ii) Delayed AGC



Simple AGC is an improvement over NO AGC case Delayed AGC is very close Ideal AGC. Delayed AGC is used in high quality receivers like communication receivers.

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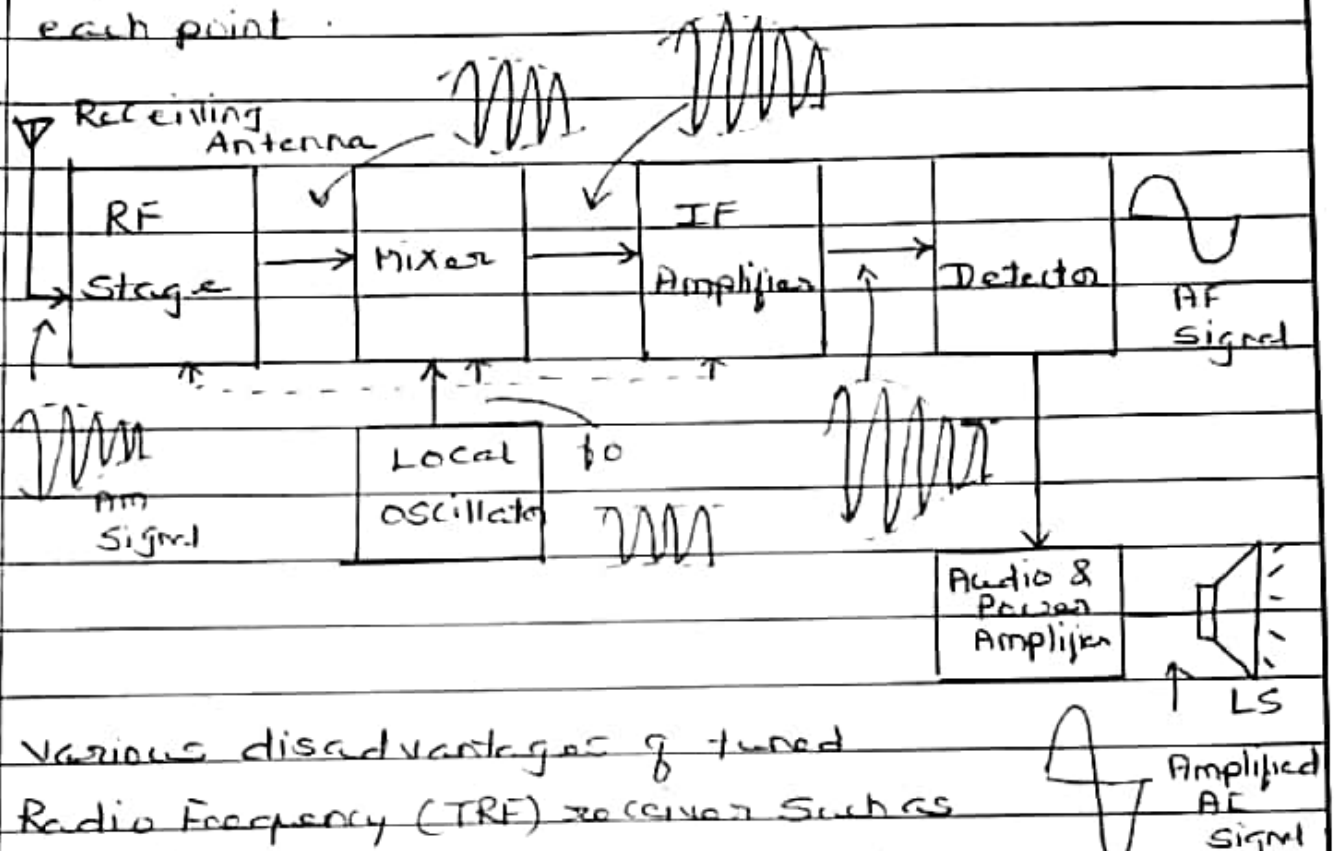
Q.2(a) Explain with the help of neat block diagram Superheterodyne receiver with waveforms at each point.



Various disadvantages of tuned Radio Frequency (TRF) receiver such as Instability, Variation in BW over tuning range and Insufficient Selectivity at high frequencies, Poor adjacent channel rejection can be overcomed by Superheterodyne Receiver.

Operation:

AM signal is transmitted and reached to receiving antenna after travelling through the air.

RF Stage

It is an amplifier which is used to select wanted signal and reject other unwanted Signals. It reduces

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the effect of noise. At the output of RF stage the desired frequency f_o is obtained

Mixer:

It receives signals from RF amplifier at freq f_s and from local oscillator at frequency f_o such that $f_o > f_s$

Intermediate Frequency (IF)

Mixer will mix these signals to produce signal $f_o - f_s$ called Intermediate frequency (IF)

$$IF = f_o - f_s$$

Simultaneous tuning of RF amplifier, mixer and local oscillator is achieved by ganged tuning. If it is amplified by one or more stages of IF Amplifier. This signal is then detected by detector to recover original modulating signal. This is then amplified and applied to the loudspeaker. AGC (Automatic Gain control) Controls the gains of RF and IF Amplifiers to maintain a constant output voltage level even when the signal level at the receiver input is fluctuating. This is done by feeding a controlling dc voltage to RF and IF amplifier. Amplitude of this dc voltage is proportional to the detector output.

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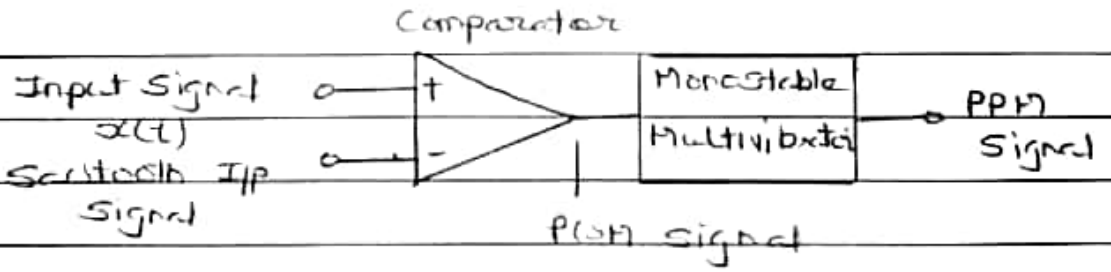
		ReAssessor
Space for Marks	Question No.	START WRITING HERE

Q.2(b) Explain generation and demodulation of PPM in detail with the help of neat waveforms

In PPM amplitude and width of the pulses remains constant but the position of each pulse is varied in accordance with amplitudes of sampled values of the modulating signal. Position of the pulses is changed with respect to position of reference pulse. PPM pulses can be derived from PWM pulses as shown in Fig below. It is noted that with increase in modulating voltage PPM pulses shift further w.r.t. reference. The PWM pulses obtained at comparator output are applied to monostable multivibrator which is negative edge triggered.



corresponding to each trailing edge of PWM signal monostable output goes high. It remains high for fixed time decided by RC components. Information is conveyed via change in position of pulses.

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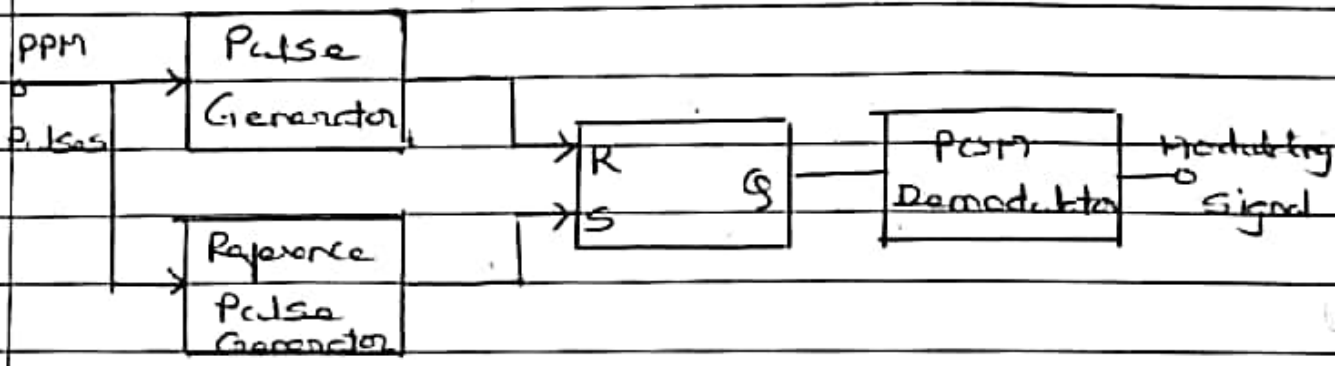
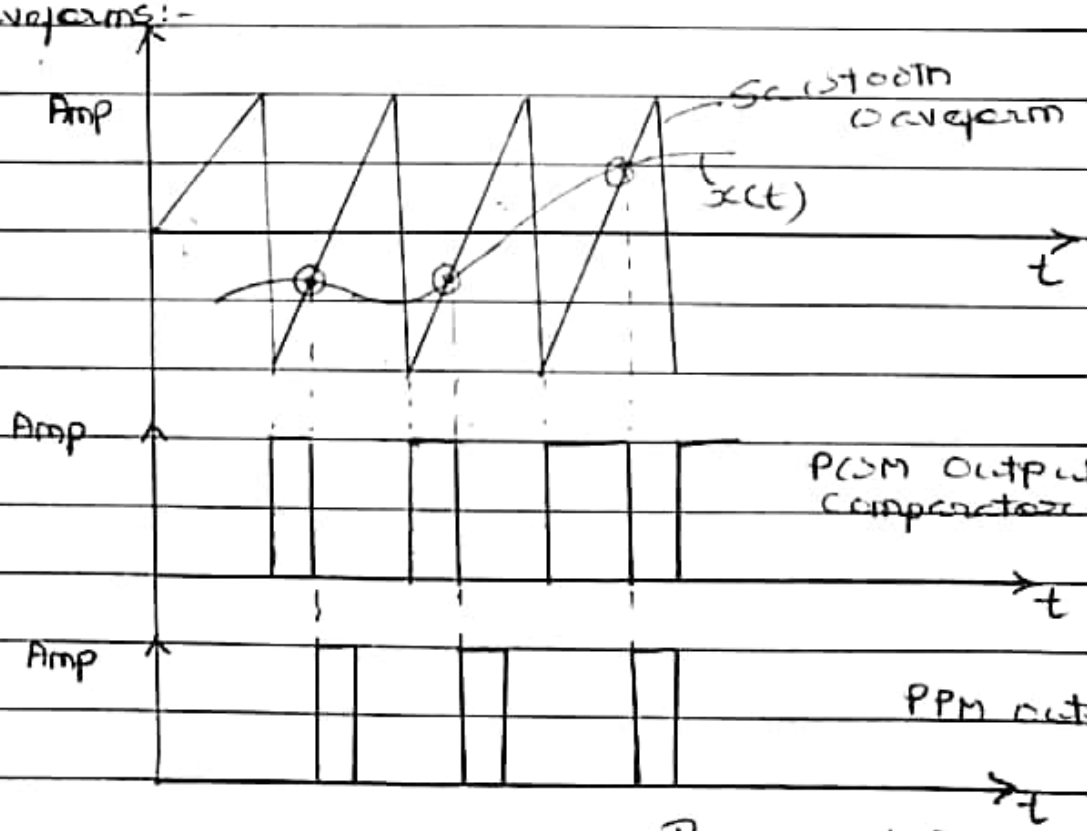
Space for Marks	Question No.	START WRITING HERE

Detection of PPM:



Noise corrupted PPM waveform is applied to pulse Generator. Pulse Generator output is applied to Reset pin of RS Flip Flop. A Fixed period reference pulse is applied to set (S) pin of RS FF. Detection process is shown below.

Waveforms:-



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Question no.		Moderator	
		ReAssessor	

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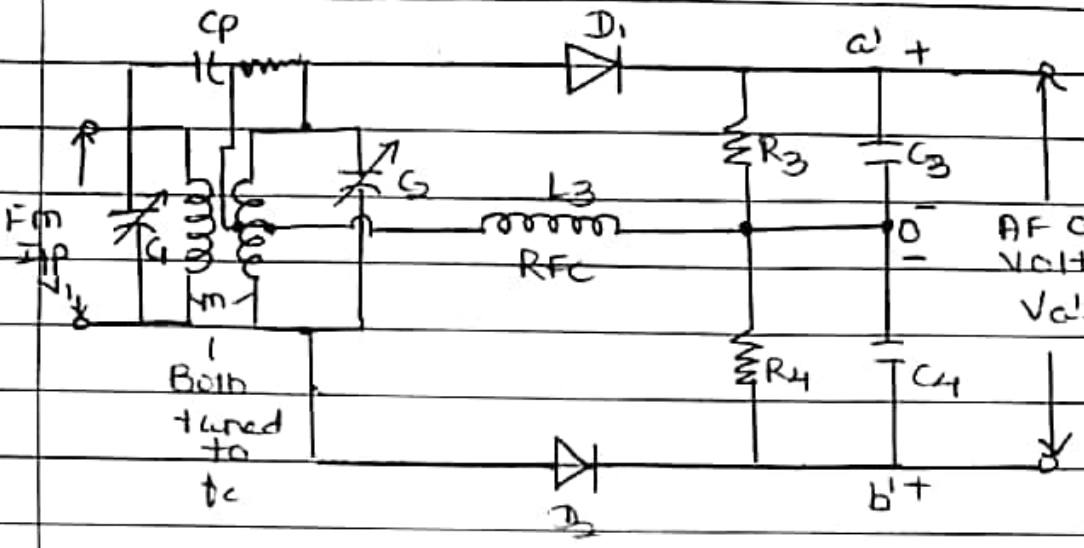
(c) Describe the operation of Foster Seeley Discriminator with the help of Phasor diagrams



Foster-Seeley Discriminator or Phase Discriminator is derived from balanced modulator

Here Primary and secondary windings both are tuned to same centre frequency 'fc' of incoming signal. This simplifies tuning process to a great extent and it will yield better linearity than the balanced slope detector.

Principle of operation:

Even though primary and secondary circuits are tuned to same centre frequency, voltages applied to two diodes D_1 and D_2 are not constant. They vary depending on frequency of input signal. This is due to change in phase shift between primary and secondary windings depending on input frequency.

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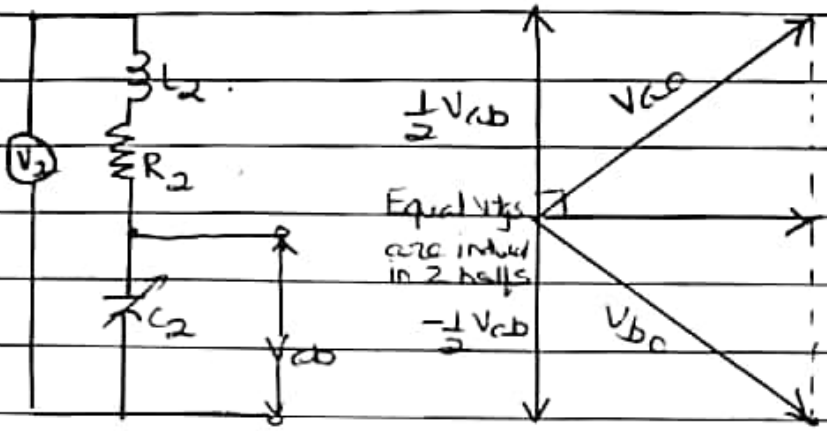
Space for Marks	Question No.	START WRITING HERE

(i) At $f_{in} = f_c$, the individual output voltages of diodes will be equal & opposite. Hence output voltage is zero

$$V_{o_1} - V_{o_2} = 0.$$

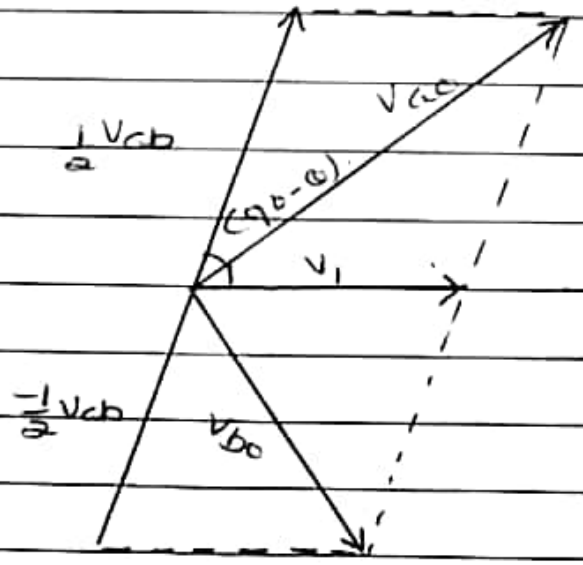


Secondary Equivalent circuit

Phasor diagram for $f_{in} = f_c$.

(ii) For $f_{in} > f_c$

Phase shift between primary and secondary windings is such that output of D_1 is higher than that of D_2. Hence output voltage will be positive



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Total Marks of Question no.		Examiner	
		Moderator	
		ReAssessor	

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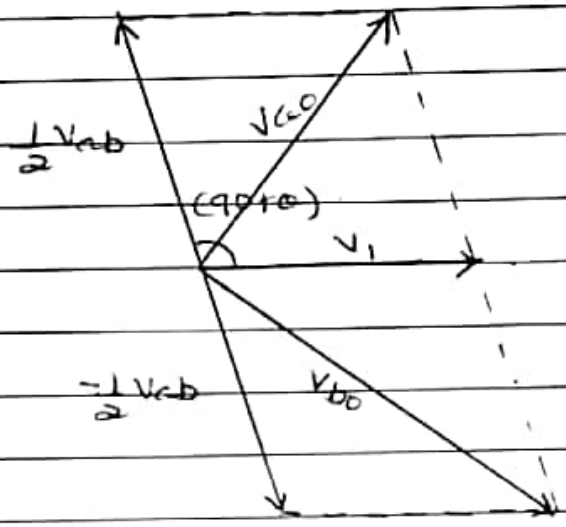
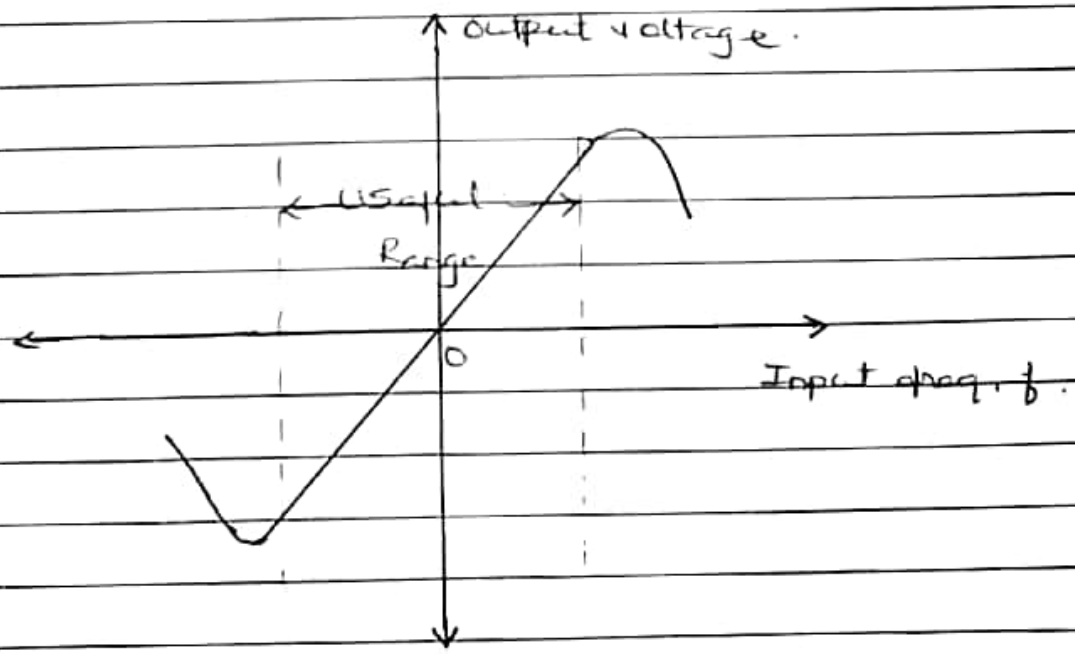
For $f_{in} < f_c$

Here the phase shift is such that output of D_2 is higher than that of D_1 making output voltage, Vo negative.



Discriminator Response is shown below:-



Advantages:

1. Linearity is better
2. It is easier to align, tune since only two tuned circuits are present.

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Space for Marks	Question No.	START WRITING HERE

Disadvantages:-

It does not provide amplitude limiting as a result of which presence of noise or other spurious amplitude variations tend to produce errors since demodulator output tends to respond to them.

(d) In a broadcast Superheterodyne receiver having no RF amplifier loaded Q of antenna coupling circuit (at the input to the mixer) is 100.

(i) If the intermediate frequency is 455 KHz. Calculate image frequency and its rejection at 1000KHz and at 25 MHz. (ii) In order to make the image frequency rejection as good at 25 MHz as it was at 1000 KHz Calculate loaded Q of RF amplifier which a receiver should have.

(i) (a) $f_s = 1000$ KHz or 25 MHz

At 1000 KHz

Image Frequency, $f_{si} = f_s + 2IF$.

$f_{si} = [1000 + 2 \times 455]$ KHz.

$f_{si} = 1910$ KHz

Image frequency rejection ratio, $\alpha = \sqrt{1 + Q^2 \xi^2}$

Where $\xi = \frac{f_{si} - f_s}{f_s \cdot f_{si}}$

$\xi = \frac{1910}{1000} - \frac{1000}{1910}$.

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Total Marks of Question no.		Examiner	
		Moderator	
		ReAssessor	

Space for Marks	Question No.	START WRITING HERE
		$\rho = 1.3865$
		$\alpha = \sqrt{1+(1.38)^2 \times (100)^2}$
		$\alpha = 138.60$
		At 25 MHz
		Image Frequency, $f_{si} = f_s + 2IF$
		$f_{si} = 25 \times 10^6 + 2 \times 455 \times 10^3$
		$f_{si} = 25.91$ MHz
		$\rho = \frac{f_{si}}{f_s} - \frac{f_s}{f_{si}}$
		$\rho = \frac{25.91}{25} - \frac{25}{25.91}$
		$\rho = 0.0715$
		$\alpha = \sqrt{1+\rho^2 Q^2}$
		$\alpha = \sqrt{1+(0.0715)^2 (100)^2}$
		$\alpha = 7.2195$
	(ii)	We want to make image frequency rejection of receiver as good at 25MHz as it was for 1000KHz.
		At 1000KHz image frequency rejection was
		$\alpha = 138.60$ & $\rho = 0.0715$
		So $f_s = 25$ MHz.
		$\alpha = \sqrt{1+\rho^2 Q^2}$
		$138.60 = \sqrt{1+(0.0715)^2 \times Q^2}$
		$Q = \frac{(138.60)^2}{(0.0715)^2}$

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Total Marks of Question no.		Examiner	
		Moderator	
		ReAssessor	

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$Q = 1938.41$

Hence to make rejection of receiver good at 25 MHz Q should be 1938.41

$$\alpha = \alpha_1' \cdot \alpha_2$$

$$138.6 = \alpha' \times 7.22$$

$$\therefore \alpha' = 19.2$$

We know that $\alpha' = \sqrt{1 + Q_1^2 g^2} = \sqrt{1 + Q_1^2 \times (1.386)^2}$

$$\therefore Q_1 = 268$$

A well designed receiver should have same Q for both tuned circuits Q has to be geometric mean of 100 and 268

$$\therefore Q = \sqrt{100 \times 268} = 163.70 = 164$$

Q 3) What is Software Defined Radio (SDR)

① SDR is a radio communication system where components have been typically implemented in hardware (e.g mixer, filters, amplifiers, modulators, demodulators etc) are instead implemented by means of software on a personal computer or Embaded system ② Basic SDR System may consists of personal computer equipped with sound card or other analog-to digital converter preceeded by some form of RF front end ③ Software radios are significantly utilized for military and cell phones services both of which must serve a wide variety of changing radio protocols in real time.

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VIT Vidyalankar Institute of Technology www.vit.edu.in	***Internal Assessment Test Paper Audit Form***		
Branch: EXTC	Semester: V	Subject: EME	Test No.1
Syllabus/Units as per lesson Plan: Module-I , Module-II			Marks:20
Time Duation:01 Hr		Time:	
Date of Test::	Marks Display Date: (x+2)week	Paper resubmission date if <10	

Q.No.	Syllabus		Question	Marks	Question Type			CO Map to Question	Score Scale(0-4)for All Question	
	Unit	Week			EQ	GQ	TP		Self Review	Reviewer
Q.1(a)	1	1	Write expression for Coulomb's law in vector form	2	√	√		Co1	3	3
Q.1(b)	1	2	Define electric flux density. Write its Unit.	2	√	√		Co1	3	3
Q.1(c)	1	4	Work done is independent of path taken. Justify.	2		√	√	Co1	4	4
Q.1(d)	1	1	What is the relation between electric potential and electric field intensity?	2		√		Co1	4	3
Q.1(e)	1	4	Define the term 'Potential Difference'	2 2	√	√		Co1	4	3
Q.1(f)	1	3	Find E due to ρ_s = 5 nC/m^2 lies along x= 2 at origin.	2		√		Co1	3	3
Q.1(g)	1	3	Calculate charge density ρv if $\vec{D} = rsin\emptyset\,\widehat{a_r} + 2rcos\emptyset\widehat{a_\emptyset} + 2z^2\widehat{a_z}$ C/m^2.	2		√		Co1	4	4
Q.2(a)	1	2	Obtain expression for Electric field intensity due to infinite line charge at each and every point in space.	5		√		Co1	4	4
Q.2(b)	1	2	Find Electric field intensity at origin due to following charges configuration ρ_L = 50 nC/m lies along x= 1 and y = 2	5	√	√		Co1	4	4
Q.2(c)	1	2	Given $\vec{D} = zrcos^2\emptyset\,\widehat{a_z}$ C/m^2 , Calculate the charge density at (1,π/4,3) and the total charge enclosed by the cylinder of raduis 1m with -2 ≤ z ≤ 2 m.	5	√	√		Co1	4	4
Q.2(d)	1	1	Two point charges Q_1 and Q_2 are located at (1,2,0) and (2,0,0) respectively. Find the relation between Q_1 and Q_2 such that the force on a test charge at the point P (-1,1,0) will have no x component.	5	√	√		Co1	4	3
Q.2(e)	1	3	Explain Gauss's law. Obtain its integral and point form.	5	√	√		Co1	4	4
Q.3	1	1	Justify 'Application of Gauss's law to non-symmetrical charge distribution tells us how flux density changes				√	Co2	4	4

			from point to point.								

Should Question be modified: No
If Yes new Question/s

No.	Question	Marks
1		
2		
3		

Model solution and marking scheme submitted on:

Name of Teacher :	Subject Teacher	Reviewer
Name :	Pravin Patil, Prof. Dattatray Bade and Prof. Prathemesh Mistry	Pravin Patil
Signature :		

VIT Vidyalankar Institute of Technology | 1 smith chart | **Internal Assessment Test**

Branch	Test Date	Semester	Div.	Roll No.	Student's Signature
EXTC (ME)	24/2/2018	II	A	17104A1010	Vaishnavi

IA Test No.	Subject
1	RFME

Junior Supervisor's full signature with date : 24/2/18

Question No.	1	2	3	Total 20	Examiners Signature	Student's Sign After receiving the assessed answer sheet
Marks obtained	10	10	—	20		Vaishnavi 28/2/2018

1] a) For given potentially unstable transistor with $|S_{11}| > 1$ and $|S_{22}| > 1$ having stability circles plotted on Smith chart

The stable region for o/p stability circle lies inside the stability circle for $|S_{11}| > 1$

The stable region for i/p stability circle lies inside the stability circle for $|S_{22}| > 1$

And the unstable regions for both i/p & o/p stability circles lie outside the stability circles.

b) K - Δ test of stability

$$|\Delta| = |S_{11} S_{22} - S_{12} S_{21}| < 1$$

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2 |S_{12} S_{21}|} > 1$$

then the device is unconditionally stable & else it will be potentially unstable.

d) Importance of Impedance matching

① Maximum power will be transferred from source to load and power loss will be minimum.

② The resistive components which are sensitive to impedance matching like antenna or LNA etc will improve signal to noise (SNR) ratio of the system

③ The power distribution in the network will reduce the amplitude & phase errors.

e) i) Transducer Gain (G_T)

$$G_T = \frac{P_L}{P_{avs}} = \frac{\text{power delivered to load}}{\text{power available at source}}$$

$$G_T = \frac{1 - |\Gamma_s|^2}{|1 - \Gamma_{in}\Gamma_s|^2} |S_{21}|^2 \frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}$$

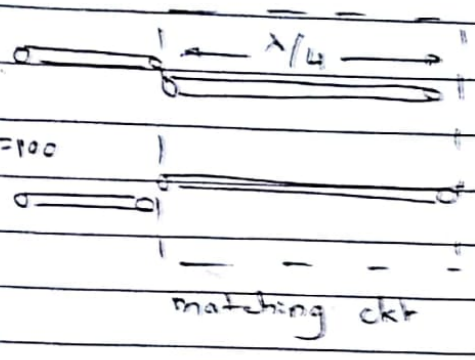
ii) Operating power gain (G_P)

$$G_P = \frac{P_L}{P_{in}} = \frac{\text{power delivered to load}}{\text{power i/p to N/W}}$$

$$G_P = \frac{1 - |\Gamma_L|^2 \; |S_{21}|^2}{|1 - S_{22}\Gamma_L|^2 \; |1 - \Gamma_{in}|^2}$$

1) $Z_L = 50\ \Omega$ ← Given

$Z_{in} = 100\ \Omega$



For quarter wave ~~transformer~~ section :

$$Z_0 = \sqrt{Z_L Z_{in}} = 70.71\ \Omega$$

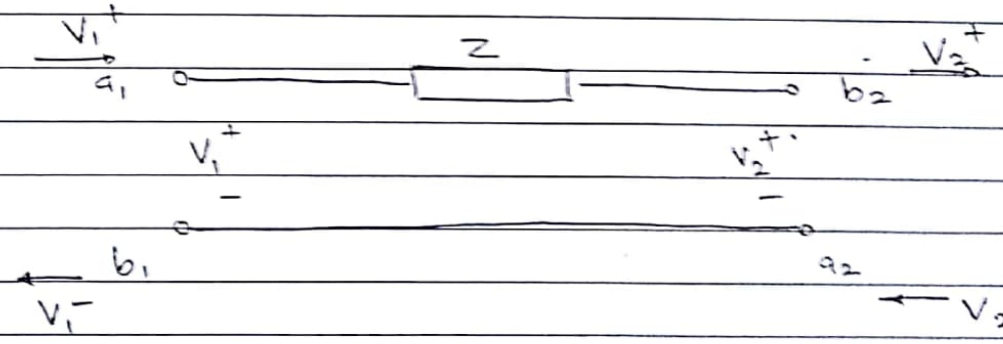
$$\boxed{Z_0 = 70.71\ \Omega}$$

Lengths :

$$Z_1 = \frac{Z_{in}}{Z_L} = \frac{100}{50} = 2$$

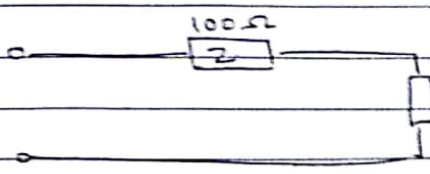
$$Z_2 = \frac{Z_{in}}{Z_{in}} = \frac{100}{100} = 1$$

2] a)



Considering $Z_L = 100\ \Omega$ & $Z_0 = 50\ \Omega$

Calc. of S_{11}



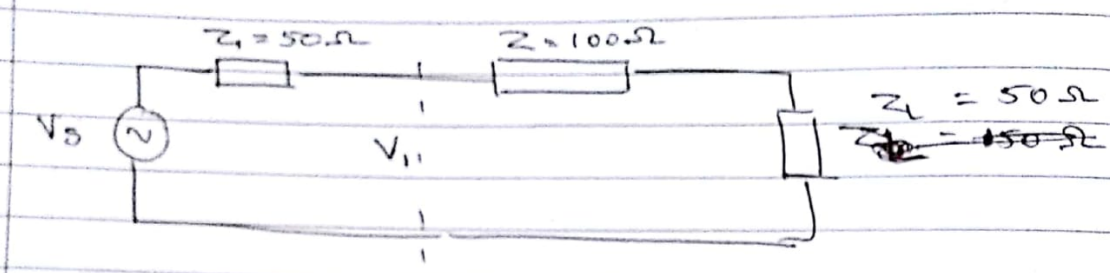
$$Z_{in} = 100 + 50$$

$$\boxed{Z_{in} = 150\ \Omega}$$

$$S_{11} = \frac{Z_{in} - Z_0}{Z_{in} + Z_0} = \frac{150 - 50}{150 + 50}$$

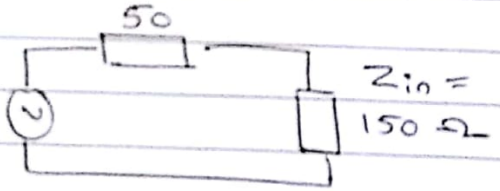
$$\boxed{S_{11} = 0.5} = S_{22} \leftarrow \text{due to N/W Symmetry}$$

Calc of S_{21} & S_{12}



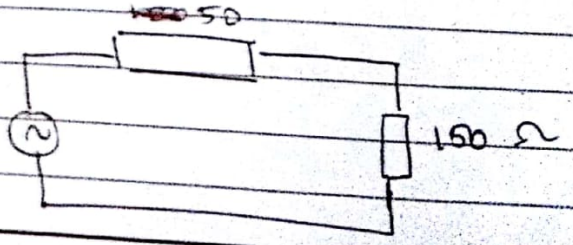
$$S_{21} = \frac{2V_2}{V_{S_1}} \quad \& \quad S_{12} = \frac{2V_1}{V_{S_2}}$$

calc V_1 in terms of V_{S_1}



$$V_1 = \frac{150}{50 + 150} V_{S_1} = 0.25\, V_{S_1}$$

calc of V_2 in terms of V_{S_2}



$$V_2 = \frac{150}{150+50} V_{S2} = 0.75\, V_{S2}$$

$$S_{12} = \frac{2V_1}{V_{S2}}$$

$$= \frac{2 \times 0.75\, V_{S1}}{V_{S1}}$$

~~$= 0.5$~~ $= 1.5$

$$\boxed{S_{12} = S_{21} = 1.5}$$ ← Due to N/W symmetry

c) $S_{11} = 0.8 \angle -170°$

$S_{12} = 0.1 \angle 80°$

$S_{21} = 5.1 \angle 70°$

$S_{22} = 0.62 \angle -40°$

$$\Delta = |S_{11} S_{22} - S_{12} S_{21}|$$

$$= |(0.8 \times 0.62) - (0.1 \times 5.1)|$$

$$= 0.496 \angle 150 - 0.51 \angle 150$$

$$= 0.014$$

$$\boxed{\Delta < 1}$$

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12} S_{21}|}$$

$$= \frac{1 - (0.8)^2 - (0.62)^2 + (0.014)^2}{2[0.1 \times 5.1)}$$

$$= 0.023$$

$K < 1$

The device is potentially unstable

o/p stability circle

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2}$$

$$= \frac{(0.62\angle -40 - (0.014)(0.8\angle 170))^*}{(0.62)^2 - (0.014)^2}$$

$$= \frac{(0.62\angle -40 - 0.0112\angle 170)^*}{(0.62)^2 - (0.014)^2}$$

$$= \frac{0.62\angle 39.49}{(0.62)^2 - (0.014)^2}$$

$$\boxed{C_L = 1.61\angle 39.49}$$ ✓

$$R_L = \left| \frac{S_{12} S_{21}}{|S_{22}|^2 - |\Delta|^2} \right|$$

$$= \frac{0.1\angle 80^\circ \times 5.1\angle 70^\circ}{(0.62)^2 - (0.014)^2}$$

$$\boxed{R_L = 1.32\angle 150^\circ}$$ ✓

$S_{11} < 1$ ← stable region is outside stability circle

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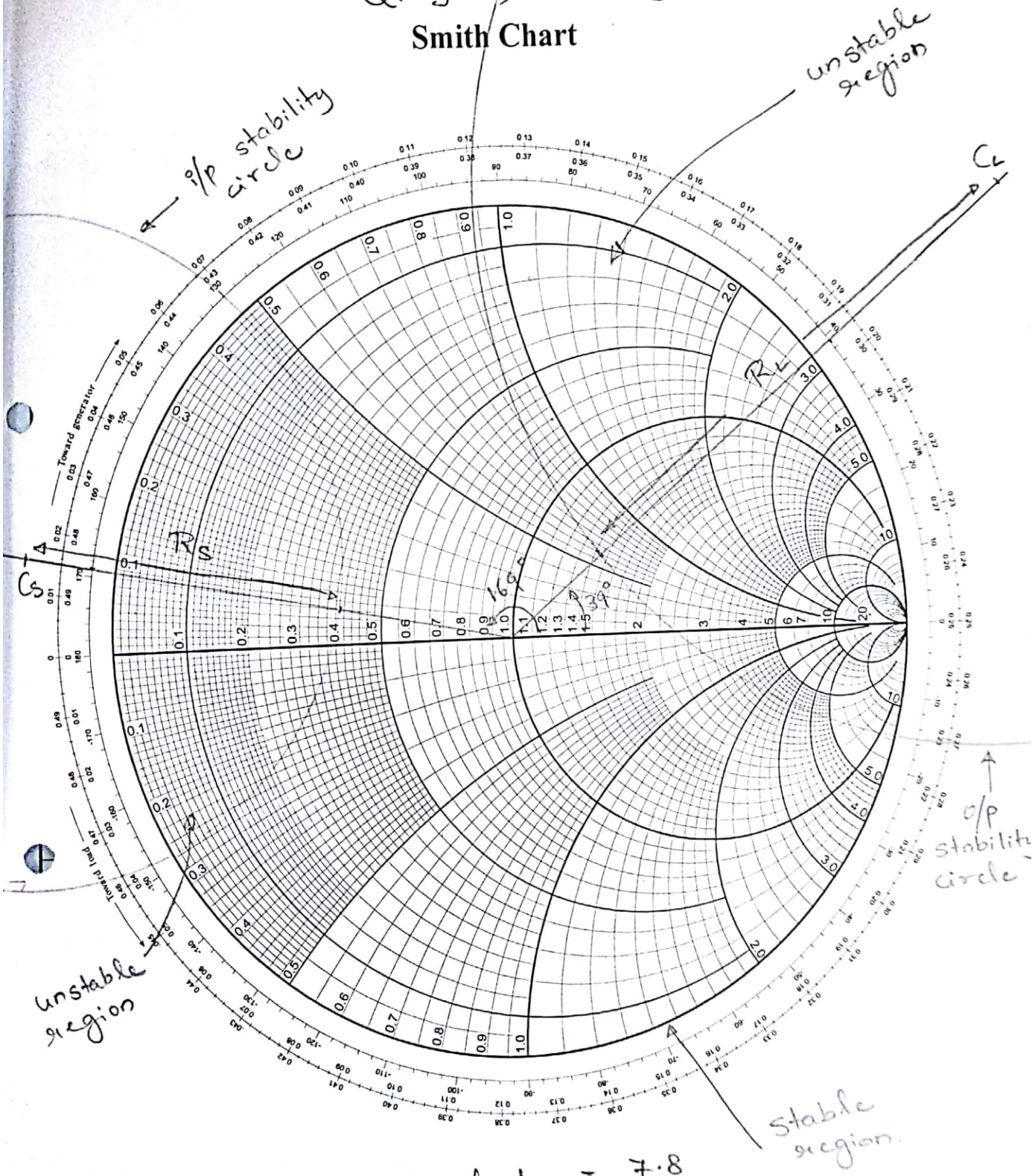
Q.2] c) Stability Circles

Smith Chart



radius of Smith chart = 7.8

p/p stability circles

$$C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2}$$

$$= \frac{(0.8\angle -170^\circ - (0.014)(0.62\angle 40))^*}{(0.8)^2 - (0.014)^2}$$

$$= \frac{0.80 \angle 169}{(0.8)^2 - (0.014)^2}$$

$$\boxed{C_S = 1.25 \angle 169}$$

$$R_S = \left| \frac{S_{12} S_{21}}{|S_{11}|^2 - |\Delta|^2} \right|$$

$$= \frac{0.1 \angle 80^\circ \times 5.1 \angle 70^\circ}{(0.8)^2 - (0.014)^2}$$

$$\boxed{R_S = 0.79 \angle 150^\circ}$$

$S_{22} < 1$ ← stable region is outside stability circle.

Calculations :

$C_L = 1.61 \times 7.8$

$\boxed{C_L = 12.55}$

$R_L = 1.32 \times 7.8$

$\boxed{R_L = 10.29}$

$C_S = 1.25 \times 7.8$

$\boxed{C_S = 9.75}$

$R_S = 0.79 \times 7.8$

$\boxed{R_S = 6.162}$