

vè; k; 15

I p̄kj 0; oLFkk



15.1 Hkfredk

I p̄kj I p̄uk oē I ā k̄k dh f̄Ø; k gā bl I ā kj dk i R; d i k. kh] vi uspkjka vlḡ oē I ā kj oē vU; i k̄. k; ka I ̄ yxHkx fujarj gh I p̄ukvka oē vknku&inku dh vko'; drk dk vuHko djrk gā fdl h I i Oy I p̄kj oē fy, ; g vko'; d gSfd i k̄kd , oaxtgh nksaka gh fdl h I oā kēU; Hk̄"kk dks I e>rs gā ekuo fujarj gh ; g iz Ru djrk jgk gSfd ml dk ekuo tkfr I s I p̄kj xqkrk eambur gā ekuo i k̄srgkfl d dky I svk/fud dky rd] I p̄kj eami ; kx gksosokyh u; h&u; h Hk̄"kkvka , oafof/; ka dh [k̄st djus oē fy, iz Ru'kny jgk g\$ rkd I p̄kj dh xfr , oatfVyrkva oē ink̄eac<rh vko'; drkva dh i frZ ḡs I oē I p̄kj iz k̄yh oē fodkl dks i k̄bur djusokyh ?kVukva , oami yfC/; ka oē fo" k; ea tkudkjh gksak ykHki n g\$ ft I s I kj. kh

15.1 ea i Zr̄q fd; k x; k gā

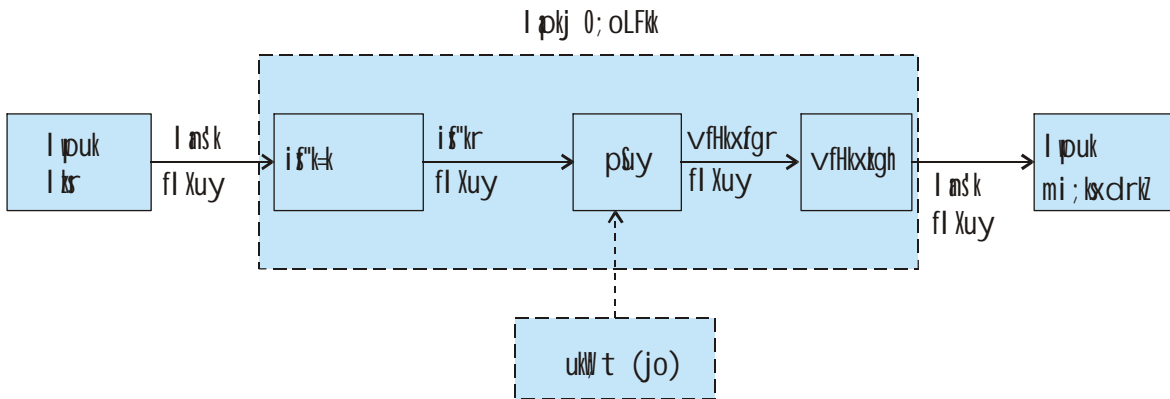
vk/fud I p̄kj dh tM̄e 19oha rFk 20oha'krkCn; ka ea I j txnh'k pl̄æ ckd] , i 0-ch-ekl ̄ th ekdk̄uh rFk vyD̄tM̄j x̄tge cy oē dk; Z }kjk Mkyh xba 20oha'krkCn oē igys i pkl o"ka oē i'pkr bl {k̄k eafodkl dh xfr ukVdh; : i I sc<k izhr gksh gā vlxkeh n'kdka eage cgr̄ I h vU; egroi w̄k mi yfC/; k̄ n̄[k I drsgā bl vè; k; dk m̄s; I p̄kj dh v̄HkdYi uk] v̄FKz̄ I p̄kj oē <k (Mode) ekW̄y u dh vko'; drkj vlḡ vk; ke&ekW̄y u oē fuxeu rFk m̄ri knu I s i f̄jpr gksak gā

15.2 I p̄kj 0; oLFkk oē vo; o

I p̄kj I Hk̄ I tho oLr̄vka oē thou oē i R; d pj. k ea0; klr gā p̄kgs I p̄kj dh d̄k̄zHk̄ i N̄fr ḡs i R; d I p̄kj 0; oLFkk oē rhu vko'; d rRo ḡrs ḡu i s'k-k] eke; eop̄s̄y rFk v̄Hkx̄tgha fp-k 15.1 eafdl h I p̄kj 0; oLFkk oē 0; ki d : i dks CyW̄d v̄kj̄k }kjk n'wz k x; k gā

I kj. kh 15.1 I pkj oð bfrgkl dh oðN i æf'k mi yf'c/; k;

o"z	?kVuk	fVli . kh
1565 bž (yxHlx)	cln'kkg vdcj dksfdl h njLFk LFKku I s cxe }kjk cPps dks tle fn; s tkus dh I puk <ksy ctkdj nsak	; g ekuk tkrk gSfd o"khj chjcy uscln'kkg vls cxe oð foJke&LFkyka oð chip fuf'pr I d; k ea <ksy ctkus okyka dh 0; oLFkk dk iz kx fd; k Fkk
1835	I E; y , iQ- ch- ekl Z rFkk I j pkYI Z OghVLVks }kjk VsyhxkHk dk vkfo"dkj	bl oð ifj.kkeLo: i Mkd?kja }kjk I msk Hkstus ea vk'p; žtud of¼ għz rFkk I msk kokgdka }kjk Lo; a ; k-k dj I msk i għpkus dk dk; Z dklkch de għx; k
1876	vyD"khj xkã csy rFkk , vksu; kses tL h }kjk VsyhHksu dk vkfo"dkj	dnkfr ekuo tkfr oð bfrgkl ea I cl s 0; ki d mi ; kx għsus okyk I pkj dk I k/u
1895	I j tsh- ckl rFkk th- ekdkh }kjk cskj oð rkj dk fun'ku	; g rkj }kjk I pkj oð ; x I sc&rkj }kjk I pkj oð ; x ea , d Āph mħku Fkh
1936	Vsyhfo"ku i d kj . k (tku ykxh cš M)	BBC }kjk i Fke Vsyhfo"ku i d kj . k
1955	egk}hi oð ikj igyk jSM; ks HADI i f'kr (vyD"khj cš)	vyD"khj cš us HADI dh vo/kj.kk 1843 ea i v/ djkbz
1968	ARPANET igyk bñjuv vLrRo ea vk; k (J.C.R. fyDyhMj)	ARPANET ifj; kstuk vesj dkl oð j'kk foHkkx }kjk I pkfyr dh xba bl oð varxž us/ooð I sl a kštr , d oð; Wj I s Hkby nit jsoð; Wj ea LFKkufjr dh x; h
1975	cy yckjv" k ij rari dkl' kdh fodfl r għz	i kjã fjd I pkj 0; oLFkkvldh rgyuk earari dkl' kd I pkj 0; oLFkk JSB rFkk I Lrh gš
1989-91	fve cuj&yh us World Wide Web dk vkfo"dkj fd; ka	www dks , d sfo'kydk; fo'odkš oð I n' k ekuk tk I drk gSftl dk Kku I od k/kj.k dks gj I e; I għk jgrk gS



þak 15.1 fdl h 0; ki d I þkj 0; oLFkk dk cyHlud vkjEKA

fdl h I þkj 0; oLFkk ea i þ'k-k fdl h , d LFkku ij vofLFkr gsrk gþ vfHlxtgh fdl h vU; LFkku ij (ikl vFkok nuj) vofLFkr gsrk gsrFkk p þy , d , d k Hkkrd ekè; e gStksbluga , d nu jsl sl a kstr djrk gþ p þy dk izdkj I þkj 0; oLFkk oþ izdkj ij fuHkj djrk gþ ; g i þ'k-k rFkk vfHlxtgh dks l a kstr djusokys , d rkj vFkok oþcy oþ : i eagsl drk gsvFkok og crkj (ok; jys) Hh gsl drk gþ i þ'k-k dk mrs ; I þuk I þr }jkk mriUu I msk fl Xuy dks p þy }jkk i þk.k oþ fy , mi ; þr : i eaifjofrþ djuk gþ ; fn fdl h I þuk I þr dk fuxþ okoþ fl Xuy dh Hkkfr vfo |qrh; gsrks dks Vrd M; u j] bl I msk dks i þ'k-k eansus l s i wZ fo |qr fl Xuy ea : i krfjr dj nrk gþ tc dksZ i þ'kr fl Xuy p þy oþ vufn'k I þkfr gsrk gsrk ; g p þy ea viwZk oþ dkj .k fo : fir gsl drk gþ bl oþ vrfjDr i þ'kr fl Xuy ea ukW t (Noise, jo) fey tkrk gþ i þyLo : i vfHlxtgh i þ'kr fl Xuy dk foNr : i i ktr djrk gþ vfHlxtgh dk dk ; Z i ktr fl Xuy dks i þkfr djuk gsrk gþ ; g bl I þuk&fl Xuy dh i þ% I þuk djoþ bl sey I msk&fl Xuy dks i þkfr l dus ; kþ ; : i ea yrk gsrkfd I msk i ktrdrkz dks i þkfr ; k tk l oþ

I þkj oþ nls ey <ak gþ 'cnq l s 'cnqrd I þkj] rFkk i þ kj .ka

'cnq l s 'cnqrd I þkj fof/ ea , d , dy i þ'k-k rFkk , d vfHlxtgh oþ chp oþ l a kst u (Linkage) l sgkdj I þkj gsrk gþ bl fof/ oþ I þkj dk , d mnkgj .k Vsyhlkksu 0; oLFkk gþ bl oþ foijhr] i þ kj .k fof/ eafdl h , dy i þ'k-k oþ rnuq ih cgr I svfHlxtgh gsrsgþ i þ kj .k fof/ }jkk I þkj oþ mnkgj .k jsm ; ks rFkk Vsyhfotu gþ

15.3 byDVHlud I þkj 0; oLFkkvka ea mi ; ksx gksus okyh ey 'kCnkoyh

vc rd ge oþN inka ('kCnk) tS sl þuk I þr] i þ'k-k] vfHlxtgh] p þy] ukW t (jo)] vkfn l s i fjpr gspþ oþ gþ ; fn ge fuEufyf[kr ey 'kCnkoyh l s i fjpr gsk tk , i rlsgeafdl h Hh I þkj 0; oLFkk dks l e>uk vkl ku gsk tk , xka

(i) VRU M; u j : dksZ ; þr tks ÅtkZ oþ , d : i dks fdl h nu js : i eaifjofrþ dj nrh gþ ml svrd M; u j dgrsgþ byDVHlud I þkj 0; oLFkkvka eageaik ; % , d h ; þr ; ka l s 0 ; ogkj djuk gsrk gSftudk ; k rls fuosk vFkok fuxþ fo |qrh ; : i eagsrk gþ fdl h fo |qrh ; Vrd M; u j dks bl izdkj ifjHkkf'kr fd ; k tkrk gþ , d h ; þr tks oþN Hkkrd þka (nkc) foLFkki u] cy]



txnh'k pñz ckl (1858 – 1937) mlgkús ijky?kq oš'q& pædh; rjæka oð tuu oð fy, ,d midj.k cuk;k vlg ml oð v¼z izk'kh; xqkka dk vè; ; u fd;ka ,d k dgk tkrk gšfd os xšysik tš sv¼pkýd dks oš'q& pædh; rjæka oð Lor% i p i k r l d p d oð : i ea mi ; l x djus okys igys 0; fDr Fk ckl usfcv'k i fcdk fn byðvfr'k; u oð 27 fml e j 1995 oð vcl earhu yč'k izk'kr fd, A 13 fml e j 1901 dks ekd k h oð igys crkj oð l p k j l snks o" k l s Hkh vf/d igys ckl oð vfo"dkj oð cjs ea 27 višy 1899 dh jkly l k l b v h dh dk; bkg h ea Hkh yč'k izk'kr gls p p k Fk ckl us , d s vfr l oð nh mi dj. Modk vfo"dkj fd; k ftuoð }kjk thfor ikf.k; ka ij cká m i h i dka dh vfr l v e i frf 0; k dks l d t p r fd; k tk l drk FkA buoð }kjk mlgkús tarq, oaokul i frd Årdka ea l ekarjrk LFk f i r d h A

txnh'k pñz ckl (1858 – 1937)

rki vkfn) dks vius fuxz ij rnuq ih fo|q; fl Xuy oð pjka ea : ikrfjr dj nrsga

(ii) fl Xuy : išk.k oð fy, mi; ðr oš'q : i ea : ikrfjr l p u k dks fl Xuy ; k l oðr dgrsga

fl Xuy ; k rks vuq i (Analog) vFkok vadh; (Digital) gls l drsga vuq i fl Xuy okvvrk vFkok /kjk oð l rr-fopj.k gksrga ; s vfuok; r% l e; oð , dy eku okys i Qyu gksrga T; k rjæ (Sine wave) , d ey vuq i fl Xuy gsrh ga l Hkh vU; vuq i fl Xuyka dks buoð T; k rjæ vo; oka oð inkaea i w k r % l e > k tk l drk ga v s y h f o " k u oð e o f u r F k n " ; fl Xuy i Ñfr eavuuq i fl Xuy gksrga vadh; fl Xuy os gksrga tks Øeokj fofodr eku i k r dj l drsga vadh; byðvfr l udh eafolrr : i ea mi ; l x gks okyh f } v k / k j h i ¼ f r e a f d l h fl Xuy oð oðoy nls Lrj gksrga ' o f u E u o k v v r k / k j k L r j oð r n u q i h g s r k s ' 1 m P p o k v v r k & e k j k L r j oð r n u q i h g k r k g a v a d h ; l p k j oð f y , m i ; l x h c g r l h d k M u i ¼ f r ; k g a b u e a l e ; k i z k f y ; k a oð m i ; ð r l a k s t u k a t s f } v k / k j h d k M r n ' k e y o (B i n a r y C o d e d D e c i m a l ; k B C D) * d k m i ; l x f d ; k t k r k g a l e ; k v l e v { k j k a r F k f u f ' p r y { k . k a d k s f u : f i r d j u s o k y k l k o z f u d : i l s y k d f i z v a d h ; d k M " A m e r i c a n S t a n d a r d C o d e f o r I n f o r m a t i o n I n t e r c h a n g e (A S C I I) ** g a

(iii) jo % jo l sgekjk rRi ; Zmu vokNuh; fl Xuyka l s g s t k s f d l h

l p k j 0 ; o l F k e a l m s k f l Xuyka oð i š k . k r F k l d k / u e a f o { k k d k i z k l d j r s g a j o m r i l u d j u s d k l k r 0 ; o l F k oð c k g j v F k o k H k r j f l F k r g l d r k g a

(iv) i š ' k - k % i š ' k - k i o s k h l m s k f l Xuy dks l d k f / r d j oð p a y l s g k d j i š k . k r F k b l oð i ' p k r v f h k x g . k oð f y , m i ; ð r c u k r k g a

(v) v f h k x t g h % d k b z v f h k x t g h p a y oð f u x z i j i k r f l Xuy l s o k a N u h ; l m s k f l Xuyka dks i k r d j r k g a

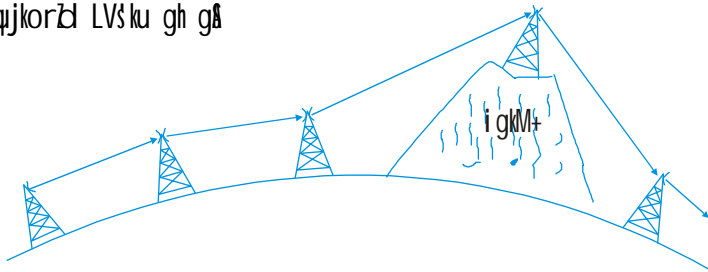
(vi) { k h . k r k % e k e ; e l s l p j . k oð l e ; fl Xuy dh icyrk ea { k r d k s { k h . k r k d g r s g a

(vii) i o / z % ; g f d l h b y ð v f r l u d i f j i F k f t l s i o / z l (l m H z v e ; k ; 1 4) d g r s g a oð m i ; l x l s f l Xuy v k ; k e (v l g i Q y L o : i m l d h r h o r k) e a o f ¼ d j u s d h i f 0 ; k g a l p k j 0 ; o l F k e a { k h . k r k oð d k j . k g k s o k y s { k ; d h { k r i f i r z oð f y , i o / z v k o ' ; d g a v f r f j D r f l Xuy i c y r k oð f y , v k o ' ; d Å t k z D C f o | q ' i k r l s i k r f l Xuy g a i o e k z u ' i k r r F k y { ; oð c h p m l L F k u i j f d ; k t k r k g s t g k f l Xuy d h i c y r k j v i š { k r i c y r k l s n e z y g l s t k r h g a

* BCD eafdl h vad dks i k ; % p k j f } v k / k j h (0 ; k 1) f e v k a } k j k f u : f i r f d ; k t k r k g a m n k j . k oð f y , n ' k e y o i z k y h e a v a k a 0 , 1 , 2 , 3 , 4 d k s 0 0 0 0 , 0 0 0 1 , 0 0 1 0 , 0 0 1 1 r F k 0 1 0 0 . 1 0 0 0 oð } k j k f u : f i r d j r s g a 1 0 0 0 v k B d k s f u : f i r d j r k g a

** p f d oð ; W j oðoy v a d k a d k s g h l e > l d r k g s v r % v a d k a oð i n k a e a f d ; k x ; k ; g y { k . k d k M u g a

- (viii) ijkl : ; g lkr rFkk y{; oð chp dh og vf/dre nýh gStgk rd fl Xuy dksml dh i; klr icyrk l s iklr fd; k tkrk gð
- (ix) cðl pks/mbz: cðl pks/mbz l sgekjk rkr; Zml vkofúk ijkl l sgsftl ij dkbz midj.k i pkfyr gsrk gsvflok Li ðVé oð ml Hkkx l sgsrk gSftl eaf l Xuy dh l Hkh vkofúk; k fo |eku gð
- (x) ekMlyu : vutHkkx 15.7 eafn, x, dkj. ka oð vud kj fuEu vkofúk oð ey; fl Xuyka (l ns kka@ l pukvka) dksvf/d nñj; kard i s'kr ughafd; k tk l drka bl hfy, i s'k-k ij fuEu vkofúk oð l ns k fl Xuyka dh l pukvka dksfdl h mPp vkofúk dh rjak ij vé; kjk s i r dj; k tkrk gStks l puk oð okgd dh Hkkfr 0; ogkj djrh gð bl i fØ; k dks ekMlyu dgrsgð t s k fd vksppkz dh tk, xh ekMlyu dbz i dkj oð gsrsgðftlga l ðki ea AM, FM rFkk PM dgrsgð
- (xi) foekMlyu % bl i fØ; k dksftl ea vfhkxtgh }kj okgd rjak l s l puk dh i q% i kflr dh tkrh gð foekMlyu dgrsgð ; g ekMlyu oð foijhr i fØ; k gð
- (xii) i þjkorð (Repeater) % i þjkorð vfhkxtgh rFkk i s'k-k dk l a kstu gsrk gð i þjkorð i s'k-k l sfl Xuy p; u djrk gð ml s i of/ r djrk gsrFkk ml svfhkxtgh dks i q% i s'kr dj nrk gð dHk&dHk rls okgd rjaka dh vkofúk ea i f jorðu Hkh dj nrk gð i þjkorð ka dk mi ; kx fp-k 15.2 ea n' kZ, vud kj fdl h l þkj 0; oLFkk dk ijkl folrkfjr djus oð fy, fd; k tkrk gð dkbz l þkj mixg okLro ea varfj{k ea , d i þjkorð LV s ku gh gð



fp-k 15.2 l þkj oð ijkl ea of¼ oð fy, i þjkorð LV s ku dk mi ; kx

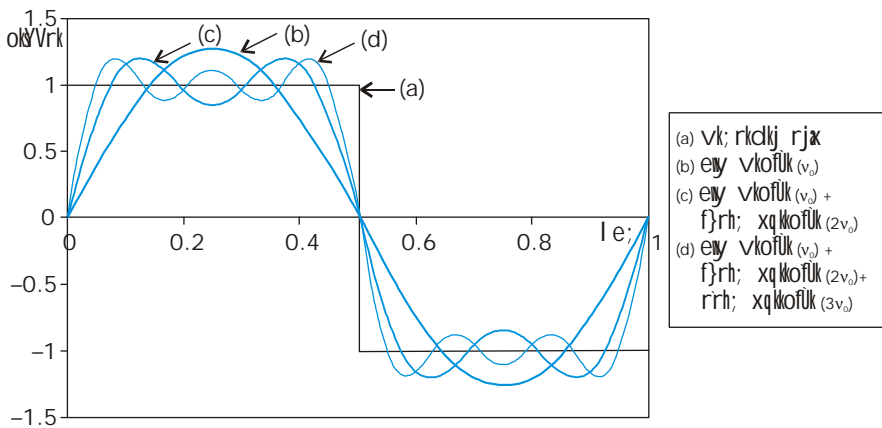
15.4 fl Xuyka dh cðl&pks/mbz

fdl h l þkj 0; oLFkk ea l ns k fl Xuy dkbz vkokt] l achr] n' ; vFkok oðl; Wj vkpdlk gks l drk gð mu fl Xuyka ea i R; d oð vkofúk ijkl fHku gsrsgð fdl h fn, x, fl Xuy dh l þkj i fØ; k dksftl izdkj dh l þkj 0; oLFkk pkfg, og ml vkofúk cðl ij fuHkj djrh gStks ml oð fy, vko' ; d ekuk tkrk gð

okoð fl Xuyka oð fy, 300 Hz l s 3100 Hz dk vkofúk ijkl mi ; Þr ekuk tkrk gð vr% okoð fl Xuyka dks 0; ki kfjd Vsyhkkku l þkj oð fy, 2800 Hz (3100 Hz – 300 Hz) cðl pks/mbz pkfg, A l achr oð i s'k.k oð fy, ok | ; akka }kj mPp vkofúk; ka oð Loj mRi l u djus oð dkj. kj yxHkx 20 kHz dh cðl pks/mbz dh vko' ; drk gsrh gð vkofúk dk J0; i f l j 20 Hz l s 20 kHz rd gð

n' ; ka oð i l kj.k (i s'k.k) oð fy, ohfM; ks fl Xuyka dks 4.2 MHz cðl pks/mbz dh vko' ; drk gsrh gð TV fl Xuyka ea n' ; rFkk J0; nkuka vo; o gsrsgð rFkk muoð i s'k.k oð fy, i k; % 6 MHz cðl pks/mbz vkoðVr dh tkrh gð

fi NysvuPnN eageusooy vuq i fl Xuyka i j gh fopkj fd; k gA vadh; fl Xuy fp-k 15.3 ean'kz, vuq kj vk; rkdj rjx dh vknfr oB gksr gA ; g n'kz k tk l drk gSfd vk; rkdj rjx dk vi?KVu (fo; kstu) $v_0, 2v_0, 3v_0, 4v_0 \dots nv_0$ vkofuk; ka dh T; koØh; rjaka oB vè; kjki .k oB : i eafd; k tk l drk gA ; gk; n , d i wkked gSft l svuar rd folrfjr fd; k tk l drk gSrfk $v_0 = 1/T_0$ gA bl rF; dh 0; k[; k oB fy , , d gh vkj[k ea ey vkofuk (v_0); ey vkofuk ($v_0 + f$)rh; xqkkoFuk ($2v_0$), ey vkofuk ($v_0 + f$)rh; xqkkoFuk ($2v_0 + r$)rh; xqkkoFuk ($3v_0$) n'kz h xbz gA bl vkj[k l s; g Li "V gSfd vk; rkdj rjx dks ; FkFkZ : i ea i q#Ri knu djusoB fy, gea l Hk xqkkoFuk; ka $v_0, 2v_0, 3v_0, 4v_0, \dots$, vkfn dks vè; kjki r djus dh vko' ; drk gksh] ft l l s ; g èofur gskr gSfd cM dh pK&MbZ vur



fp-k 15.3 ey T; k rjx rFk bl dh xqkkoFuk; ka oB i nka ea vk; rkdj rjx dk l fludVu

pkfg, A rFkfi 0; kogkj d k; k oB fy, mPp xqkkoFuk; ka oB ; ksnku dh mi[k dh tk l drk gSft l s cM pK&MbZ l hfer gk tk, xhA bl oB i fj. kelo: i vfHkxghr rjaka i f"kr rjaka dh rjyuk ea fo: fir gkshA ; fn cM pK&MbZ bruh vf/d gSfd bl ea oB xqkkoFuk; k l ek; kstr gk l drk gA rls l puk dh dkBZ {kfr ugha gksh gS rFk oB fy feykj vk; rkdj fl Xuy i ktr gk tkrk gA bl dk dkj .k ; g gSfd ftruh mPp xqkkoFuk gksh gS rjx : i oB fy, bl dk ; ksnku mrug dh de gskr gA

15.5 i k. k ekè; e dh cM&pK&MbZ

l msk fl Xuyka dh gh Hkfr fofHku i zkj oB i k. k ekè; eka oB fy, fHku&fHku cM&pK&MbZ dh vko' ; drk gksh gA i k. k ea l keld; r% mi ; kx fd , tkusokyekè; e&kj] eDr vkdk' kj rFk izkf' kd&rrooey gA l ek{h oBcy 0; kid : i l smi ; kx gkusokyk rkj ekè; e gStksyxHlx 750 MHz dh cM&pK&MbZ inku djrk gA bl izkj dk oBcy l keld; r% 18 GHz vkofuk l suhpsipkyr gskr gA jSM; ksrjaka dk mi ; kx djoB eDr vkdk' k l svkofuk; ka oB , d folrr ifj l j (oB l gi kHz l soB GHz rd) ea l pkj gskr gA bl vkofuk ifj l j dksrkfydk 15.2 ean'kz, vuq kj fi Qj l soHkfr dj fofo/ l ok, j inku djusoB fy, vkofv fd; k tkrk gA rnyka dk iz, kx djoB izkf' kd l pkj vkofuk ifj l j 1 THz l s 1000 THz rd (l e rjaka l s j k s kuh rd)] l i lu fd; k tkrk gA , d izkf' kd rny 100 GHz l svf/d dh l pkj cM&pK&MbZ inku dj l drk gA

, d varjzVh; l e>kfsoB ifj. kelo: i] Li DVè dh fofHku cM&pK&Mb; ka dk vkofv fd; k x; k gA vkofuk vkofv dh orèku 0; oLFk dk l pkyu varjzVh; nji l pkj ; tu; u (International Telecommunication Union ; k ITU) djrh gA

I kj.kh 15.2 oþN iæðk crkj I þkj vkofúk cM

I ok	vkofúk cM	fVli . kh
ekud AM ið kj.k	540-1600 kHz	
FM ið kj.k	88-108 MHz	
Vsyhfó"ku	54-72 MHz 76-88 MHz 174-216 MHz 420-890 MHz	VHF (vfr mPp vkofúk) TV UHF (ijk mPp vkofúk) TV
I Ý; wj ekkby jSM; ks	896-901 MHz 840-935 MHz	ekkby I s vk/kj LVs ku oð fy, vk/kj LVs ku I sekkby oð fy,
mi xg I þkj	5.925-6.425 GHz 3.7-4.2 GHz	mi fjfyð v/kfyð

15.6 osl rppðh; rjaka dk I þj.k

jSM; ks rjaka dk mi; lxx djusokys I þkj ea, d fl sj ij ið"kk glerk gSftl dk, ðhuk osl rppðh; rjaka fofðjr djrk gð tks varfjðk ea xeu djrh gðznit jsfl jsij fLFkr vfHkxkgh oð, ðhuk ij igprh gð tð & tð sosl rppðh; rjaka ið"kk l snij glerk tkrh gS oð & oð sbudh rhork de glerk tkrh gð osl rppðh; rjaka oð I þj.k rFkk xeui Fk dks dbz dkjd i Hkkfor djrs gð; gk ij iFoh oð okrkj.k dh I þpuk dks l e>uk Hkh egðoi wlk gSD; kðd osl rppðh; rjaka oð I þj.k ea bl dh l fð; Hkkfedk gð I kj.kh 15.3 ea ok; pðly dh oþN mi; lxx l rgka dk l ð{ktr foj.k fn; k x; k gð

15.6.1 Hkk&rjaka

fl Xuyka dks mPp n{krk l sfoðfjr djus oð fy, ðhuk dk l kb"k fl Xuy dh rjaks; 2λ oð rnyuh; (de l sde $\sim \lambda/4$) glerk pðfg, A yach rjaks; k (vFkkz fuEu vkofúk); oð fy, ðhuk oð Hkkfðd l kb"k cM+glers gð rFkk mlga iFoh oð i"b ij vFkok bl oð cgr ikl yxk; k tkrk gð ekud vk; ke&ekwlyr (AM) ið kj.k ea Hkk&vk/kfjr Åeokz/ Lrbkka (Vkbj) dk 0; ki d mi; lxx iðk.k, ðhuk dh Hkkfr glerk gð bl izdkj oð, ðhuk l sfl Xuy oð ið kj.k ij Hkkie dk izy i Hkko glerk gð I þj.k dh bl fof/ dks i"Bh; rjaka I þj.k dgrs gð rFkk; g rjaka iFoh dh i"B ij fol izk djrh gð; g rjaka iFoh oð ftl Hkkx l s xðjrh gSml ij /kj iðj djrh gS rFkk iFoh }kj k ÅtZ oð vo'wsk.k oð dkj.k rjaka {kh.k glerk tkrh gð vkofúk ea of $1/4$ oð l kFk i"Bh; rjaka dh {kh.krk earhork l s of $1/4$ glerk gð vr% ið"kr dh tk l dus okyh vkofúk dk vf/dre ijkl ið"kr 'kðr rFkk bl dh vkofúk (oþN MHz l sde) ij fuHkj djrk gð

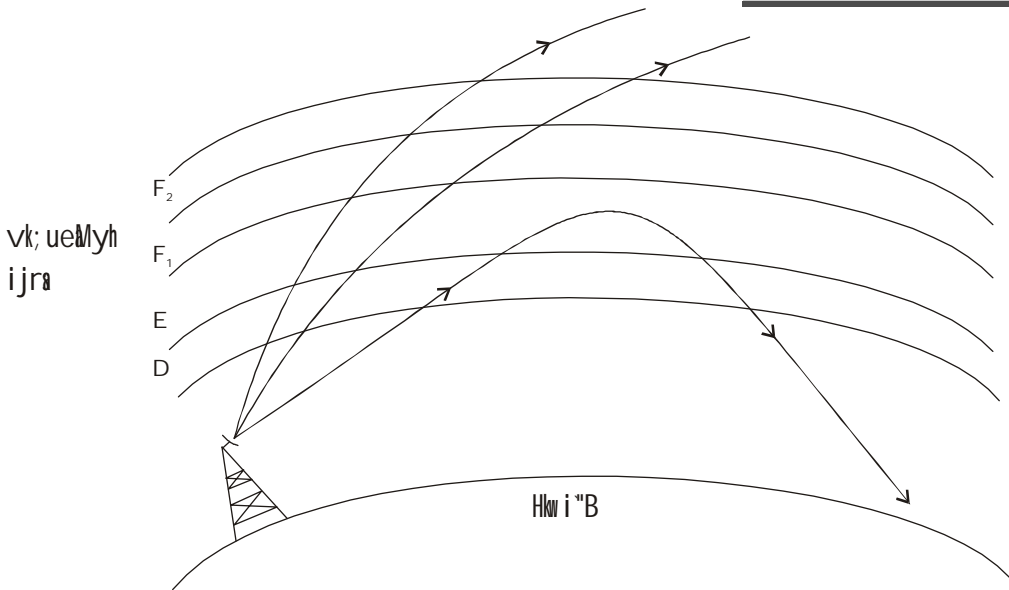
I kj.kh 15.3 ok; eMy dh fofHkku l rga rFk mudh l pfr os rppcdh; rjaka l s vU; k; fØ; k

Lrj (l rg) dk uke	i Foh oð i "B l s l fludV rgrk	vfLro dh vof/	l okZ/d i Hkkfor vkofuk; k;
{kðik eMy	10 km	fnu o jkr	vfr mPp vkofuk (dbzGHz rd)
D (l erki eMy dk Hkx)	vk ; 65-75 km	oðoy fnu	fuEu vkofuk i jkofrZ_ oðN vðk rd eè; vkofuk rFk mPp vkofuk; k; vo'kð'kr
E, (l erki eMy dk Hkx)	u ea 100 km	oðoy fnu	i "Bh; rjaka dk l gk; d] mPp vkofuk; k; i jkofrZ
F ₁ (eè; eMy dk Hkx)	M y 170-190 km	fnu oð l e;] jk=k ea F ₂ oð l kfk foyhu	mPp vkofuk; ka dk vkf' kd vo'kð.k djrsqg Hkx mlga F ₂ rd i gpusnsk
F ₂ (Fkell i Gh; j)	Hk x jk=k ea 300 km fnu oð l e; 250-400 km	fnu o jkr	mPp vkofuk rjaka dk n{krki oð l i jkorZ] fo'kðkj jk=k oð l e;

15.6.2 0; kE rjaka

oðN MHz l s 30 l s 40 MHz oð vkofuk i fj l j ea vf/d nih dk l pkj] jSM; ks rjaka oð vk; ueMyh i jkorZ }kj k i p% i Foh ij oki l ykVus oð dkj.k l lko gk i krk gð bl i zdkj oð l pj.k dks 0; kE rjaka l pj.k dgrsg rFk bl dk mi ; ks y?krjaka i l kj.k l okvka }kj fd; k tkrk gð bl svk; ueMy dgusdk dkj.k ; g gsfD D; kðd ; gk vk; u vFkok vkos'kr d.k vR; fekD l d; k eaglsrsgð ; g vkdk'k ea i Foh oð i "B l s ~ 65 km l syxHkx 400 km Åptbz rd i ðyk gðvk gð tc l wZ l smPp ÅtkZ ðr fofdj.k rFk i jkcsuh fdj.k ok; qoð l á oð ea vkrh gðrks ok; qoð v.kqvk; fur gk tkrsgð bl oð vfrfjDr vk; ueMy dbz i jrka eafokkfrtr gsrk gð ft l sfolrkj l s l kj.kh 15.3 ean'kðz k x; k gð vk; uu dh ek-k rgrk (Åptb) ij fuHkj djrh gð ok; eMy dk ?kuRo Åptbz c<us ij ?krk gð vf/d Åptb; ka ij l k fofdj.k rhoz gsrsgð i jrvk; fur gkus oð fy, oðN gh v.kpmi yC/ gsrsgð Hkx i "B oð l ehi ; | fi vkf.od l kærk (?kuRo) dki Gh vf/d gsrk gð i jarqfodj.k. ka dh rhoz de gkus oð dkj.k ; gk vk; uu de gsrk gð rFkfi] eè; Åptb; ka dh oðN l Fkfr; ka ij vk; uu ?kuRo oð mPp eku ik, tkrsgð vk; ueMyh; i jr] 3 MHz l s 30 MHz i fj l j dh vkofuk; ka oð fy, i jkorZ dh Hkfr dk; Z djrh gð 30 MHz l smPp vkofuk dh os rppcdh; rjaka vk; ueMy dk Hknu djoð iyk; u dj tkrh gð ; g i fj?kVuk fp=k 15.4 ean'kðz h xbz gð os rppcdh; rjaka oð cædu dh i fj?kVuk ft l oð i ðyLo; i os i Foh oð i "B dh vlg ekM+nh tkrh gð i zdkf'kdh oð i wZ vkrfjd i jkorZ oð l n'k gh gð*

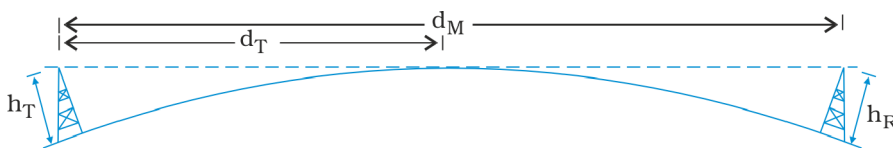
* fejt dh i fj?kVuk l s rgyuk djð



fp= 15.4 0; k= rj= l pj. k l kj. kh 15.3 ea i jrka dk ukedj. k fn; k x; k g=

15.6.3 vdkk'k rj=

vdkk'k rj= }kjk i d kj. k j=; ksrj= o= i d kj. k dk , d vl; <= g= vdkk' k=rj= i =k. k=, v= huk l svfHkxtgh, v= huk rd l jy js[kh; i Fk ij xeu djrh g= vdkk'k rj= adk mi ; k= n"Vjs[kh; j=; k l pj. k [line-of-sight (LOS) radio communication] o= l kfk gh l kfk mi xg l pj ea Hk fd; k tkrk g= 40 MHz l svf/d vkoflk; ka ij l pj o=oy n"Vjs[kh; (LOS) j=; k l pj. k }kjk gh l blko g= bu vkoflk; ka ij , v= huk dk l kb" k vi= k= N= Nk/ k gk= k g= SRFk bl si Foh o= i" B l sdbzrj= n=; k= dh =pkbz ij LFKfir fd; k tk l drk g= LOS i Nfr dk l pj gk= o= dkj. k] fp= 15.5 ean' k=, vuq kj] i Foh dh o=ork o= dkj. k l h/h rj= afdl h =cnqij vojkr/ r gk= tkrh g= ; fn fl xuy dksf{ kfrt l sijs i klr djuk g= rls v= Hkxtgh , v= huk dklkh v= d =pkbz ij LFKfir fd; k tkuk pkfg, rkd og LOS rj= adkschp ea jkd l o=



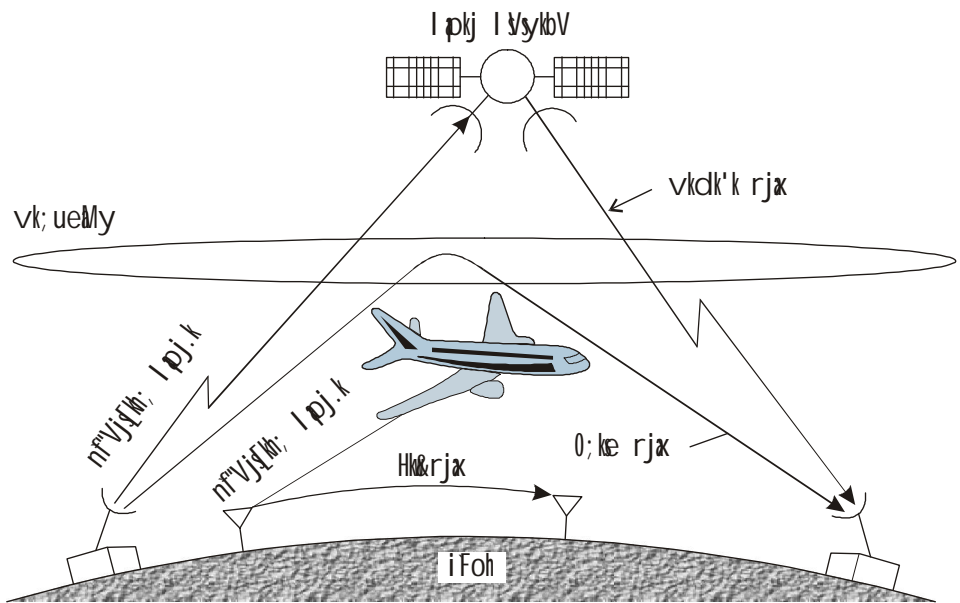
fp= 15.5 vdkk'k rj= }kjk n"Vjs[kh; l pj=

; fn i =kd , v= huk h_T =pkbz ij g= rls vki ; g n' k= l drs g= fd f{ kfrt dh njh d_T dk eku $d_T = \sqrt{2Rh_T}$ gk= k] ; gk R i Foh dh o=ork f= kT; k (yxHkx 6400 km) g= d_T dk i =kd , v= huk dk j=; ksrj= o= Hk dgrs g= fp= 15.5 o= l nHkz e= i Foh o= i" B l s h_T rFk h_R =pkbz okys nls , v= huk o= chp dh v= fdre n"Vjs[kh; njh bl i d kj 0; Dr dh tk l drh g=

$$d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R} \quad (15.1)$$

; gk h_R v= Hkxtgh , v= huk dh =pkbz g=

Vsyhfo"ku id kj.kj elb0koo&yd rFkk l vly/bv l pj.k mu l pj.k izkkfy;ka o0 o0N mnkgj.k g0 tks vdk'k rjx id kj.k <ax dk mi ; lxx djrh g0 fp-k 15.6 eavc rd rjx l pj.k dh of.kr fof/ fof/ ; ka dk l kjk0k fn ; k x ; k g0



fp-k 15.6 o0 rppcdh; rjxka o0 l pj.k dh fof/ fof/ ; k

mnkgj.k 15.1

mnkgj.k 15.1 fdl h ehukj o0 'k'iz ij LFkfr i kcd , wuk dh Apk0z32 m rFkk vfhkxgh , wuk dh Apk0z50 m g0 LOS fo/k eal rkskud l pj.k o0 fy, nkska, wuk o0 chp dh vf/dre njh D; k g0 (i Foh dh f-kT; k = 6400 km)

gy

$$d_m = \sqrt{2 \times 64 \times 10^5 \times 32} + \sqrt{2 \times 64 \times 10^5 \times 50} \text{ m}$$

$$= 64 \times 10^2 \times \sqrt{10} + 8 \times 10^3 \times \sqrt{10} \text{ m}$$

$$= 144 \times 10^2 \times \sqrt{10} \text{ m} = 45.5 \text{ km}$$

15.7 ekMyu rFkk bl dh vko'; drk

t0 k fd igyso.ku fd; k tk p0k gsf d fdl h l pj.k 0; oLFk dk mif'; l pj.k vFkok l msk fl Xuyk dks i'kr djuk g0 l msk fl Xuyk dks vk/kj c0 fl Xuy Hk dgrsg0 tks vko'; d : i l sml ey fl Xuy jkjk fu: fir vkofuk c0 dks fufnzV djrk g0 ft l s l pj.k l kr jkjk i nku fd; k x ; k g0 0; ki d : i l s dkbz Hk fl Xuy , dy vkofuk dk T; ko0 ughagrkj oju og , d vkofuk ifl j] ft l s fl Xuy c0 p0k0z dgrsg0 ea i byk gkrk g0 eku yhft, ge J0; vkofuk (Audio frequency ; k AF) o0 fdl h byDVMLud fl Xuy (ft l dh vk/kj c0 vkofuk 20 kHz l s de g0) dks fdl h y0s i jk dh njh ij l h/sg h i'kr djuk pkrsg0 vkb,] ; g Kkr djafd os dks dks l s d kjd g0 tks gea, d k djus l s jk d rsg0 rFkk ge mu ij o0 l s i kj i k rsg0

15.7.1 ,Þhuk vFkok ,fj; y dk lkb"k

fdl h fl Xuy dls i f"kr djusoð fy, geafdl h ,Þhuk ; k , fj; y dh vko'; drk gkrh gð dkbz , Þhuk ml fl Xuy ea le; oð l kfk gks okys ifjorðu mfpr : i l s l ðnu dj l oð bl oð fy, ; g vko'; d gsfð ml , Þhuk dk l kb"k ml fl Xuy l s l æ¼ rjæns; $L(\lambda)$ oð rgyuh; gks (l kb"k de l s de $\lambda/4$ gks) 20 kHz vkofúk dh fdl h oð rppðdh; rjæ dh rjæns; $L = 15$ km gkrh gð Li"V gsfð bl yækbz oð rgyuh; l kb"k dk , Þhuk fufeðr djuk rFkk i þkfy r djuk l hko ughagð vr% , d svk/kj&cð ml fl Xuy ka dk l h/k i ðk.k 0; kogkfjd ughagð ; fn i ðk.k vkofúk mPp (mkgj. kfk; ; fn $v = 1$ MHz gsrks $\lambda = 300$ m) gð rksmi ; þr yækbz oð , Þhuk }kjk i ðk.k l hko gks l drk gð vr% gekjs; u vkofúk vk/kj cð ml fl Xuy eafufgr l þuk dls fdl h mPp jðM; ks vkofúk; ka ea i ðk.k l s iðz : i krfjr (*translate*) djus dh vko'; drk gkrh gð

15.7.2 fdl h ,Þhuk }kjk i Hkkoh 'kFDr fofdj.k

fdl h jðh; , Þhuk (yækbz = n) l s gks okys fofdj.k dk l s kðrd vè; ; u ; g n'kzk gsfð , Þhuk }kjk fofdj. 'kFDr $(1/\lambda)^2$ oð vuðekuj krh gkrh gð bl dk rki ; L; g gsfð , Þhuk dh l eku yækbz oð fy,] rjæns; $L\lambda$ oð rkvus ij (vfkðr vkofúk ea of¼ gks ij) fofdj. 'kFDr ea of¼ gks krh gð vr% fdl h yæh rjæns; Loð vk/kj&cð ml fl Xuy }kjk i Hkkoh 'kFDr fofdj.k de gkrh gð vr% fdl h vPNs i ðk.k oð fy, gea mPp 'kFDr þfg, vlg bl hf, ; g rF; gea i ðk.k oð fy, mPp vkofúk oð mi ; kx dh vko'; drk n'kzk gð

15.7.3 fofHkðu i f"kkæ l s i klr fl Xuy ka dk feJ.k

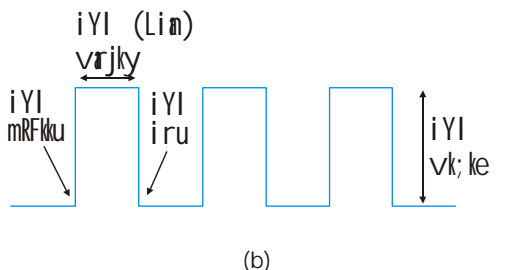
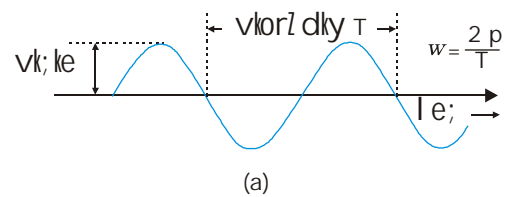
vk/kj&cð l ððrka oð l h/s iðkj.k (i ðk.k) oð fo#¼ , d vl; egðoi wð roð vf/d 0; kogkfjd gð eku yfðt, cgr l s 0; fDr, d gh le; dkrphr dj jgsgð vFkok , d gh {k.k dbz i f"kkæ vk/kj&cð l þuk fl Xuy i f"kr dj jgsgð ; s l Hkh fl Xuy , d ðnið jsoð l kfk fey tkrs gð rFkk bueafðHknu djus dk dkbz l j y mik; ughagð ; g l hkkfor gy oð : i eamPp vkofúk; ka ij , d , d s l þkj oð mi ; kx dh vlg l ððr djrk gð ft l ea i R; d l mðk fl Xuy oð i ðk.k oð fy, vkofúk; ka dk , d cð ml vkofv r fd; k tkrk gð

mi jkðr roð ; g l þkrk gsfð u; u vkofúk oð emy vk/kj cð ml ; k l þuk fl Xuy dk i ðk.k l s iðz fdl h mPp vkofúk rjæ ea : i ksj.k vko'; d gð ; g : i ksj.k i fð; k bl iðkj dh gks h þfg, fd : i krfjr fl Xuy eamu l Hkh l þukvkað l ekoðk jgs tkemy fl Xuy ea l efg r FkA , d k djusoð fy, ge fdl h mPp vkofúk fl Xuy] ft l sokgd rjæ dgrsgð dh l gk; rk yrs gð og i fð; k ft l oð }kjk okgd rjæ oð l kfk l þuk dls l y/xu fd; k tkrk gsekMlyu dgryh gð okgd rjæ l rr (T; koðh;) vFkok Lim oð : i eafp-k 15.7 ean'kð, vuðkj gks l drh gð

fdl h T; koðh; okgd rjæ dls bl iðkj fu: fir fd; k tk l drk gð

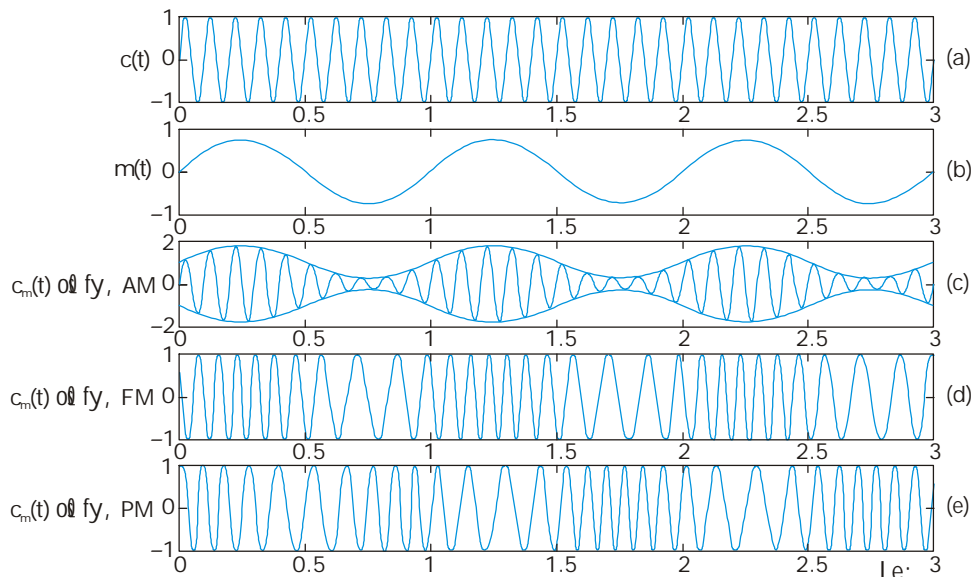
$$c(t) = A_c \sin(\omega_c t + \phi) \tag{15.2}$$

; gk c(t) fl Xuy rhork (okv r k vFkok /kj) A_c vk; ke] $\omega_c (= 2\pi v_c)$ dls h; vkofúk rFkk



þp-k 15.7 (a) T; koðh; rFkk (b) Lim (iYI) vðNfr fl Xuy

ϕ okgd rjx dh vkjāHkd dyk gā ekMyu dh ifØ; k eabu rhukā ikpyk eal sokgd rjx oð fdl h Hkh , d ikpy A_c , ω_c rFk ϕ dks l ns'k vFkok l pūk fl Xuy }kjk fu; fkr fd; k tk l drk gā bl oð ifj.kkLo: i rhu izdkj oð ekMyu gksrk gā (i) vk; ke ekMyu (AM); (ii) vkofūk ekMyu (FM); rFk (iii) dyk ekMyu (PM) tš k fd fp=k 15.8 ean'kz; k x; k gā



fp=k 15.8 fdl h okgd rjx dk ekMyu% (a) T; koØh; okgd rjx (b) ekMyd fl Xuy (c) vk; ke ekMyu (d) vkofūk ekMyu rFk (e) dyk ekMyu

bl h izdkj fdl h Lim oð rhu egroi wZ y {k.k gksrk gā Lim vk; ke] Lim vof/ vFkok Lim pkbZ rFk Lim flFkr (tis Lim oð vk; ke eaf¼ ; k fxjkoV oð dky dks fufnZV djrh g) ftlga fp=k 15.7 (b) ean'kz; k x; k gā vr% Lim ekMyu oð foFHku izdkj gS% (a) Lim vk; ke ekMyu (PAM), (b) Lim vof/ ekMyu (PDM) vFkok Lim pkbZ ekMyu (PWM), rFk (c) Lim flFkr ekMyu (PPM) bl vè; k; oð vrxZ ge vi uh pplZ dks vk; ke ekMyu rd gh l hfer j [kkā

15.8 vk; ke ekMyu

vk; ke ekMyu eakgd rjx oð vk; ke eal pūk fl Xuy oð vuð kj ifjorZ gsrk gā ; gk ij fdl h T; koØh; fl Xuy dks ekMyd fl Xuy oð : i eami ; k djoo ge vk; ke ekMyu ifØ; k dks Li "V djxā

eku yhf t, $c(t) = A_c \sin \omega_c t$ okgd rjx dks fu: fir djrh g] rFk $m(t) = A_m \sin \omega_m t$ ekMyd fl Xuy vFkok l ns'k dks fu: fir djrh gS tcf d] $\omega_m = 2\pi f_m$ l ns'k fl Xuy dh dks kh; vkofūk gā rc ekMyr fl Xuy $c_m(t)$ dks bl izdkj 0; Dr fd; k tk l drk gā

$$c_m(t) = (A_c + A_m \sin \omega_m t) \sin \omega_c t$$

$$= A_c \left[1 + \frac{A_m}{A_c} \sin \omega_m t \right] \sin \omega_c t \tag{15.3}$$

è; ku nhft,] vc l ns'k fl Xuy ekMyr fl Xuy eavrf o"V gā bl sfp=k 15.8(c) ealHk n[kk tk l drk gā l ehdj.k (15.3) l sge ; g fy [k l drs gā

$$c_m(t) = A_c \sin \omega_c t + m A_c \sin \omega_m t \sin \omega_c t \tag{15.4}$$

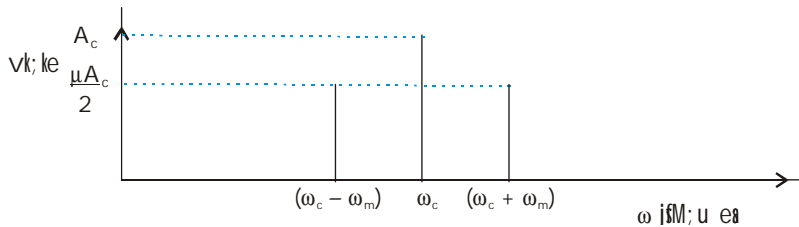
ekMyu vj foekMyu
http://www.williamson_labs.com/480_mod.htm

; gk $\mu = A_m/A_c$ ekMyu l pdkd gð fo: i.k l scplo oð fy, 0; ogkj eð $\mu \leq 1$ j [kk tkrk gð

f-kdskferh; l $\cos A \sin B = \frac{1}{2} [\cos(A-B) - \cos(A+B)]$ dk mi; l djoð ge l ehdj.k 15.4 oð $c_m(t)$ dks bl iðkj 0; Dr dj l drs gð

$$c_m(t) = A_c \sin \omega_c t + \frac{\mu A_c}{2} \cos(\omega_c - \omega_m)t - \frac{\mu A_c}{2} \cos(\omega_c + \omega_m)t \quad (15.5)$$

; gk ij $(\omega_c - \omega_m)$ rFkk $(\omega_c + \omega_m)$ dks ðe' l% fuEu ik' oZ vkofúk rFkk mPp ik' oZ vkofúk dgrs gð bl iðkj vc ekMyr fl Xuy eð ω_c vkofúk dh okgd rjæ oð l kfk nls T; koðh; rjæ ftudh vkofúk; k l soðN fHku gðh gð vlg ftlga ik' oZ cM dgrsgð varfo"V gðh gð fp-k 15.9 eð ekMyr fl Xuy dk vkofúk Li ðVe n' kð k x; k gð



fp-k 15.9 fdl h vk; ke ekMyr fl Xuy dk vk; ke o ω oð chp xðkka

tc rd ið kjr vkofúk; k (okgd rjæ) i; klr nfr; ka ij j [kh tkrk gð rfd ik' oZ cM , d nls j s j vfr0; kfir u gð fofHku LVSk u , d nls j seafuk ck/k igppk, iþkfyrgsl drsgð

mngj. k 15.2 10 kHz vkofúk rFkk 10 V f'k [kj okVrk oð l msk fl Xuy dk mi; l fdl h 1 MHz vkofúk rFkk 20 V f'k [kj okVrk dh okgd rjæ dsekMyr djusefd; k x; k gð (a) ekMyu l pdkd rFkk (b) mri l u ik' oZ cM Kkr dhft, A

gy

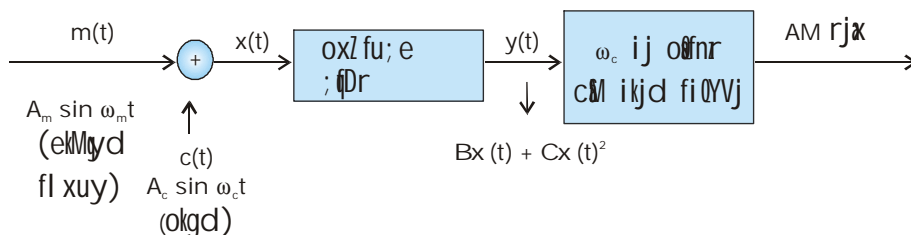
(a) ekMyu l pdkd = 10/20 = 0.5

(b) ik' oZ cM (1000+10) kHz = 1010 kHz rFkk (1000-10 kHz) = 990 kHz ij gð

mngj. k 15.2

15.9 vk; ke ekMyr rjæ dks mri l u djuk

vk; ke ekMyu mri l u djusoð fof/ <æ gsl drsgð fp-k 15.10 eð Cykkl vkjðk eabl dh , d l j l dYiukred fof/ n' kð h xbl gð



fp-k 15.10 AM fl Xuy iðr djusoð fy, l j ekMyd dk Cykkl vkjðk

; gk fl Xuy $x(t)$ dks mRi lu djus oð fy, ekMyd fl Xuy $A_m \sin \omega_m t$ dks okgd fl Xuy $A_c \sin \omega_c t$ eafeyk; k tkrk gð bl fl Xuy $x(t) = A_m \sin \omega_m t + A_c \sin \omega_c t$ dks fi Oj oxl fu; e ; ØDr tksfd , d vjS[kd ; ØDr gð l s xqkjrS gð bl idkj mRi lu fuxr gS%

$$y(t) = Bx(t) + Cx^2(t) \tag{15.6}$$

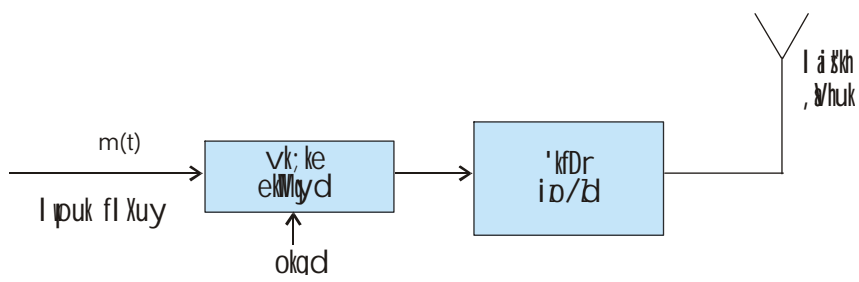
; gk B rFk C fu; rkd gð bl idkj

$$y(t) = BA_m \sin \omega_m t + BA_c \sin \omega_c t + C[A_m^2 \sin^2 \omega_m t + A_c^2 \sin^2 \omega_c t + 2A_m A_c \sin \omega_m t \sin \omega_c t] \tag{15.7}$$

$$= BA_m \sin \omega_m t + BA_c \sin \omega_c t + \frac{CA_m^2}{2} + A_c^2 - \frac{CA_m^2}{2} \cos 2\omega_m t - \frac{CA_c^2}{2} \cos 2\omega_c t + CA_m A_c \cos(\omega_c - \omega_m)t - CA_m A_c \cos(\omega_c + \omega_m)t \tag{15.8}$$

; gk ij] fkdskferh; l a/ka sin²A = (1 - cos2A)/2 rFk sinA sinB oð fy, l a/] ft l s igysHk mi ; kx fd; k tk pdk gð dk mi ; kx fd; k x; k gð

l ehdj.k (15.8) , d dc in C/2 (A_m² + A_c²) rFk vkoflk; ka ω_m, 2ω_m, ω_c, 2ω_c, ω_c - ω_m, ω_c + ω_m oð T; koØ gðtS k fd fp=k 15.10 ean'kz; k x; k gð bl fl Xuy dks cM i kjd fi QYVj* l s xqkjrS gð tks dc vo; o rFk vkoflk; ka ω_m , 2ω_m rFk 2ω_c oð T; koØka dk fujkdj.k djoð ω_c, ω_c - ω_m, ω_c + ω_m vkoflk; ka dks ifr/kfjr dj yrsk gð bl idkj cM i kjd fi QYVj dk fuxr dk l ehdj.k (15.5) oð l eku : i gskr gð vr% ; g , d AM rjx gskh gð ; gk ; g mYyS[k djuk vko' ; d gSfd ekMyr fl Xuy dks , d sgh iS'kr ughafd; k tk l drk ekMyd dk vuæeu , d 'kDr id/ð djrk gS tks fl Xuy dks vko' ; d 'kDr inku djrk gð bl idkj ikr ekMyr fl Xuy dk l bkj.k fdl h mi ; Ør l ko" k oð , w/huk dksfd; k tkrk gS tks fp=k 15.11 ean'kz, vuq kj fl Xuy dks fofdfjr dj nrk gð



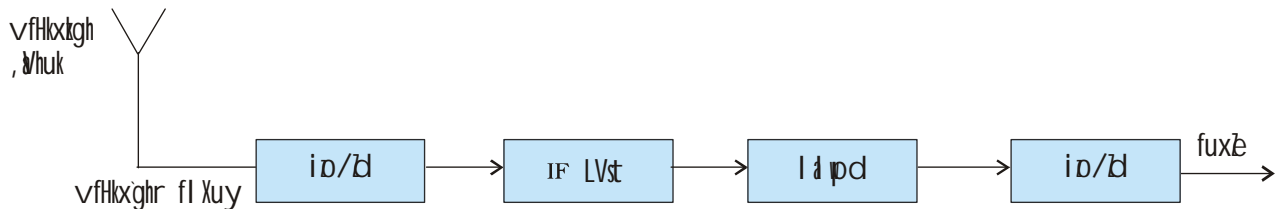
fp=k 15.11 iS'kr dk Cymk&vkjS[ka

15.10 vk; ke ekMyr rjx dk l a pu

pðy l s id kj.k ea iS'kr l msk {k.k gks tkrk gð vr% vfHkxkgh , w/huk fdl h idkðd rFk l a pd dk vuæeu djrk gð l kfk gh] l a k/u dh l fo/k oð fy, okgd vkoflk dks ik; % fdl h eè; vkoflk (IF) pj.k ij l a pu l s iWZ fuEu vkoflk ea ifjofr' dj yrsk gð l a fpr

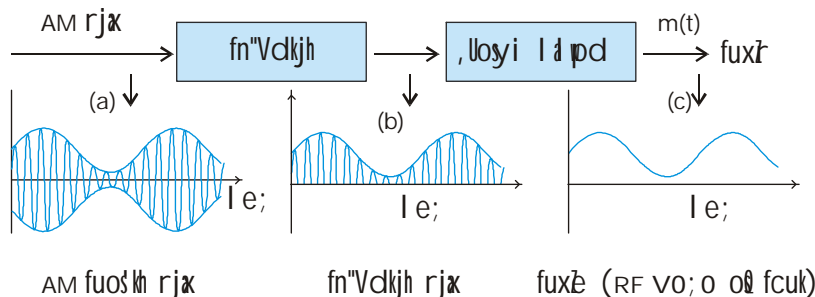
* cM i kjd fi QYVj U; w rFk mPp vkoflk; ka dk fujkdj.k dj nrk gS rFk vkoflk; ka oð , d cM dks xqkjrS nrk gð

fl Xuy bruk icy ugha gsrk fd ml dk mi ; lsk fd ; k tk l oðj vr% ml s iðf/r djus dh vko' ; drk gsrh gð fp-k 15.12 eafdl h iz ih vfhkxtgh dk Cykkl&vkjçk n'kz k x ; k gð



fp-k 15.12 vfhkxtgh dk Cykkl&vkjçk

Ið pu og ifð; k gsftl oð }kjk ekMfyr okgd rjæ l sekMfyd fl Xuy dh iψ% i kflr dh trrh gð geus vHkh ; g nçkk Fkk fd ekMfyr okgd rjæ ea ωc rFkk ωc ± ωm vkoflk; k gsrh gð bl l s vkoflk ωm okys dlskh; ey l msk fl Xuy m(t) dls i kflr djus dh , d l jy fof/ fp-k 15.13 ea Cykkl&vkjçk oð : i ean'kz h xbz gð



fp-k 15.13 AM fl Xuy oð Ið pd dk Cykkl&vkjçk y-v{k oð fy, Hkðrd jkf'k okVrk vFlak ækkjk gls l drh gð

ekMfyr fl Xuy] ftl dk : i fp-k 15.13(a) ean'kz k x ; k gð fnVdkjh l s xçkkjk trrk gsftl oð iðyLo: i (b) ean'kz, vuð kj fuxð i kflr gsrk gð fl Xuy (b) dk ; g , Loyi gh ey fl Xuy gð fl Xuy m(t) dh iψ% i kflr oð fy, bl l msk fl Xuy (b) dls, Loyi Ið pd (tks, d l jy RC ifji Fk gsrk gð) l s xçkkjk trrk gð

bl vè; k; ea geus l þkj rFkk l þkj 0; oLFkkvka dh oðN ey l adYi ukvka oð fo" k; ea pplzd h gð bl eageus, d fof' k"V izlkj oð vuð i ekMfyuþvk; ke ekMfyu (AM) oð fo" k; ea Hkh pplzd h gð ekMfyu oð vL; izlkjar Fkk vadh; l þkj 0; oLFkk dh Hkh vk/ðud l þkj ea egroi wLz Hkðedk gð bl {sk ea i frnu vL; mltstuki wLz fodkl dk; l gls jgs gð

vc rd geus viuh pplzd dls oðN ey l þkj 0; oLFkkvka rd gh l hfer j[kk gð bl vè; k; dls l ekr djus l sigys ge vki dls vk/ðud l e; dh oðN mu l þkj 0; oLFkkvka dh >yð fn[kkuk þgrs gðftul sgekjs nðud thou ea l þukvka oð vlnku&inku oð <x ea vkeypny ifjorðu mRi lu gls x ; k gð

vfrfjDr tkudkjh

bà/juſ

bl 0; oLFkk dk l kjs l á kj ead jk/Meami HksDrk mi ; lsk dj jgsgà bl 0; oLFkk oð varxž fdl h fo'kky , oatfVy us'ood l sl a kstr nls ; k vf/d oðl ; Wjka oð chp gj izdkj dh l pukvka dk vknku&inku , oal pjk dk vol j iklr gkrk gð ; g 1960 ea vkjtkk gqk rFkk l oð k/kj.k oð fy, 1990 l sl gyHk fd ; k x ; ka l e ; oð l kfk ml eafoLi Qs/d of¼ gðz gS tks viuh igpp dk fujrj foLrkj dj jgh gð bl oð fuEufyf[kr vuqz ; lsk gð

- (i) b&esy % ; g b&esy l kMVoſ j dk mi ; lsk djoð i kB ; l kexb&vkys[th l kexb oð vknku&inku dh l fjo/k ink u djrk gð ge dkbzi=k fy[kdj ml sISP's (bà/juſ l oð inkudrkt) oð }kjk i=k ikusokys oð ikl Hkst l drsgð ; gk ISP Mkd?kj oð : i ea i=k Hkst us vlg iklr djus dk dk ; Z djrk gð
- (ii) i Qby Vta i Qj : i Qby LFkkurj dk ; Døe (FTP) bà/juſ l stt/ls , d oðl ; Wj l sni js oðl ; Wj dks i Qby@ kMVoſ j LFkkurjfr djus dk vol j ink u djrk gð
- (iii) oYMZ okbM os (www) % , d soðl ; Wj tks ni js l sckj us oð fy, vius Hkhrj oðN fo'k"V l puk l xfgR djrs gð ; k rls Lo ; agh vFkok os l oð ink u djus okya oð }kjk dkbz os l kbV ink u djrs gð 'kl dh ; foHkx] dEi fu ; kj v'kl dh ; l xBu (NGO) rFkk dkbzO ; fDr Hkh vius fØ ; kdyki ka oð fo"k ; ea l hfer vFkok eðr mi ; lsk oð fy, viuh l puk bl ea ns l drsgð ; g tkudkjh bl oð mi HksDrk vka oð fy, l gyHk (igpp oð Hkhrj) gk tkrh gð cgr l sl pZ batu tS s ; kgyj xxy vkfn l oð/r os l kbVka dh l pñ cukdj tkudkjh iklr djus ea gekjh l gk ; rk djrs gð os dk , d vR ; r 'kDr' kcyh y{k.k gkbij VDLV gS tks Lor% gh gea ikl fxd tkudkjh nus oð fy, tkl+HTML (gkbij VDLV ekolvi ykost) dk mi ; lsk djoð os oð , d i"B dks ni js i"B l stkl+nsk gð
- (iv) b&dkt l Z % byðV mlud l k/uka tS soðMV dkmZ dk mi ; lsk djoð bà/juſ oð mi ; lsk }kjk 0 ; ki kj dks i kbur djuk] b&dkt l Z dgykrk gð xkgd fofo/ mRi knka , oal oðvka oð ifrcæka dks n[kdj foHku oð i fu ; ka oð os l kbV }kjk muoð mRi knka , oal oðvka oð fo"k ; ea tkudkjh iklr dj yrs gð os ?kj vFkok vkni O l soLrp/ka dh vkni ykbu [kjh nkjh dj l drsgð oð i fu ; k olrq ; vFkok viuh l oð ; Mkd }kjk vFkok oðfj ; j l oð }kjk ink u dj nrh gð
- (v) ckrphr&xi 'ki % l eku #fp oð 0 ; fDr ; ka }kjk Vki fd , gq l ns kka }kjk ckrphr dks pſ (Chat) djuk dgrsgð pſ xij ea l fefyr dkbz Hkh 0 ; fDr rRdkfyd l ns k iklr djoð rjgr gh mlkj ns l drk gð

vufyfi (FAX)

; g byðV mlud fl Xuy mRi lu djus oð fy, fdl h fyf[kr iek.k dh fo"k ; olrq dk (ifrcæ oð : i ea fo"k ; olrq dh Hkfr ugh) Øeoh{k.k djrk gð ; sfl Xuy fi Qj ml dh efty (ni jh FAX e'khu) rd l keW ; <x l sVsyhlkksu dh ykbu }kjk Hksts tkrsgð efty ij igpus oð i'pkr fl Xuyka dks FAX e'khu ewy fyf[kr iek.k ka dh ifrÑfr ea i q% ifjoerr dj nrh gð è ; ku nus ; k ; ckr ; g gSfd FAX e'khu] fdl h flFkj fyf[kr iek.k dk ifr'cc ink u djrh gð Vsyhfo"ku dh Hkfr xfr'khy olrp/ka oð ifr'cc ink u ugha dj l drh

ekskby Vsyhlkksu

ekskby Vsyhlkksu dh ifjdYiuk l oð Eke 1970 oð n'kd ea fofdl r dh xbZ vlg vxys n'kd ea bl si wkt-% ykwdj fn ; k x ; ka bl 0 ; oLFkk dh oðeh ; vfhk/kj.k oð vuq kj l elr l oð {sk dks mfpr l ã ; k oð d{k ka ea ckj/ yrs gð ; s d{k fdl h vkni O l ft l eskkby Vsyhlkksu fl oFpax vkni O l (MTSO) dgrsgð ij oðfær j [krs gð i R ; k d{k oð ikl , d fuEu 'kDr i s'k k gSft l scd LVS ku dgrsgð rFkk ; g eskkby fjl hojka (ft l sckypky ea l sy Hkksu dgrsgð) dh cMk l ã ; k dks l oð ink u djrk gð i R ; d d{k oð ikl oðN oxl fdykshVj vFkok bl l s Hkh de {sk gkrk gS tks mi HksDrk vka dh l ã ; k ij fuHk] djrk gð tc dkbz eskkby fjl hoj fdl h , d cð LVS ku oð {sk l sckgj fdl h vl ; {sk ea tkrk gS rts ; g vko' ; d gSfd ml eskkby mi HksDrk dks ml h cð LVS ku ij LFkkurjfr fd ; k tk , A bl dk ; Zof/ dks gð/vkoj ; k gð/vkni dgrsgð ; g ifØ ; k vR ; f/d rhork l spykz tkrh gS rFkk mi HksDrk bl ij è ; ku rd ugha ns i k rka eskkby Vsyhlkksu iz ih <x l svkofk ; ka oð UHF ifjl j (yxHkx 800-950 MHz) ea i pkyr fd , tkrsgð

I kjk k

1. byðVNUd I þkj dk rRi ; ZI þuk vFkok I nska (tkoSj q okVrk ; k /kj k oð : i ea miyC/ gksrgð) dls, d ãcnqI sni js ãcnqrd fo'ol uh; <æ I sLFkkularfjr djuk gð
2. fdl h I þkj 0; oLFkk oð rhu ey , dduI á ðkd] I á ðk.k&pðy] rFkk vfHkxkgh gksrgð
3. I þkj 0; oLFkk oð nls egROIwiz izdkj vuq i rFkk vadh; I þkj gð vuq i I þkj ea ið kfjr dh tkusokyh I þuk 0; ki d : i I sl arr rjxor gsrh gð tcfv vadh; I þkj ea ek-fofoDr vFkok DokúVr Lrj oð gksrgð
4. iR; d I ns k fl Xuy dk , d vkofúk i fjI j gsrk gð fdl h I ns k fl Xuy dh cM&pM&MbZ dk rRi ; Zml vkofúk&cM I s gsrk gStlsmI I ns k fl Xuy eavrfó"V I þuk I nskstud i ðk.k oð fy, vko' ; d gsrk gð bl h izdkj dkbZHh 0; kogkfjd I þkj&0; oLFkk vkofúk oð oðoy fdl h i fjI j dlsgh i ðk.k dk vol j inku djrh gsvkð bl h dksml I þkj 0; oLFkk dh cM&pM&MbZ dgk tkrk gð
5. fuEu vkofúk; ka dls ych njih rd I á ð"kr ughafd; k tk I drk gð vr% bl s, d fo'kSk i fð; k ftI s ekMyu dgrs gð oð }kj k fdl h mPp vkofúk oð okgd fl Xuy ij vè; kjk i r fd; k tkrk gð
6. ekMyu ea okgd fl Xuy oð oðN y{k.k tð s vk; ke] vkofúk vFkok dykj ekMyd vFkok I ns k fl Xuy oð vuq i ifjofrZ gsrksgð rnuq kj foHkU ekMyr rjaka dls vk; ke ekMyr (AM), vkofúk ekMyr (FM), vFkok dyk ekMyr (PM) rja dgrs gð
7. Lin ekMyu dk oxhðj.k bl izdkj fd; k tkrk gS% Lin vk; ke ekMyu (PAM), Lin vof/ ekMyu (PDM) vFkok Lin pM&MbZ ekMyu (PWM), rFkk Lin fLFkr ekMyu (PPM)
8. yach nfi; kard I á ðk.k oð fy, fl Xuyka dls vkdk' k ea oðN ; qDr; ka oð }kj k fofdfjr fd; k tkrk gSftUga , þhuk dgrs gð ; sfofdfjr fl Xuy oð rppædh; rjaka oð : i ea ið kfjr gksrgð rFkk muoð ið kj.k dh fo/k dls i Foh rFkk bl dk ok; þMy i Hkfor djrk gð i Foh oð i "B oð fudV oð rppædh; rjaka i "Bh; rjaka oð : i ea ið kfjr gsrh gð i "Bh; ið kj.k oðN MHz vkofúk; kard gh mi ; ksch gsrk gð
9. i Foh oð fdlUghans ãcnq/ka oð chp yach njih dk I þkj vk; ueð/y }kj k oð rppædh; rjaka oð i jkorZu }kj k I hko gsrk i rkrk gð bl izdkj dh rjaka dls 0; ke rjaka dgrs gð 0; ke rjaka dk ið kj.k yxHkx 30 MHz vkofúk rd gh gsrk drk gð bl vkofúk I svfæd vkofúk dh oð rppædh; rjaka vfuok; Z: i I svkdk' k rjaka oð : i ea ið kfjr gsrh gð vkdk' k rjaka dk mi ; ksch n"Vjðkh; I þkj rFkk mi xg I þkj ea gsrk gð
10. ; fn dkbZ , þhuk n_T ÁþkbZ I soð rppædh; rjaka fofdfjr djrk gð rksml oð ifjI j a_T dls $\sqrt{2Rn_T}$ }kj k 0; Dr fd; k tkrk gð ; gk æ i Foh dh f=K; k gð
11. vk; ke ekMyr fl Xuy ea $(\omega_c - \omega_m)$, ω_c rFkk $(\omega_c + \omega_m)$. vkofúk; k gsrh gð
12. I ns k fl Xuy rFkk okgd rja dls fdl h vjð[kd ; qDr ij vuqz qDr djoð rFkk fi Új ml s cM i kjd fi ÚVj I s xqkj dj] vk; ke ekMyr fl Xuy i ktr fd; k tkrk gð
13. AM I d þu fdl h AM rja : i I sekMyd fl Xuy dh i q% i kfr dh og i fð; k gS ftI oð I þkyu eafdl h fn"Vdkjh rFkk , loysi I d þpd dk mi ; ksch fd; k tkrk gð

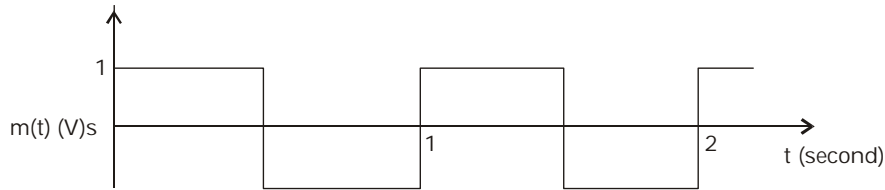
fopkj . kh; fo" k;

1. I mskel ppuk fl Xuy oel I a sk. k rFkk vfHkxg. k dh i fØ; k eafI Xuy oel I kFk ukW t (jo) tM+ tkrk gA D; k vki bl ukW t oel oqN I kr crk I drs gA
2. ekMyu dh i fØ; k eau; h vkofuk; k ftlga ik' oZM dgrs gA okgd rjx vkofuk oel nkuka vkj (okgd vkofuk I svf/d rFkk de) mRi lu gk tkrk gA budk ifjek. k vf/dre ekMyd vkofuk oel cjkj gkrk gA D; k (a) oBoy ik' oZM (b) oBoy , d ik' oZM dls i f"kr djoel I msk dh i q% i kflr I lko gk I drh gA
3. vk; ke ekMyu ea ekMyu I pdkd $\mu \leq 1$ dk mi ; kx fd; k tkrk gA ; fn $\mu > 1$ gsrks D; k gskk?

vH; kl

- 15.1 0; ke rjxk oel mi ; kx }kjk f{krft oel ikj I pkj oel fy, fuEufyf[kr vkofuk; ke ea I s dks I h vkofuk mi ; q r jgsk\
 - (a) 10 kHz
 - (b) 10 MHz
 - (c) 1 GHz
 - (d) 1000 GHz
- 15.2 UHF ifj I j dh vkofuk; ke dk i d kj. k ik; % fd I oel }kjk gskk gA
 - (a) Hk&rjxk
 - (b) 0; ke rjxk
 - (c) i "Bh; rjxk
 - (d) vkdk' k rjxk
- 15.3 vdh; fl Xuy %
 - (i) ekuka dk I rr I epp; inku ugha djrd
 - (ii) ekuka dks fofoDr pj. ka oel : i ea fu: fir djrs gA
 - (iii) f}vk/kjh i ¼fr dk mi ; kx djrs gA
 - (iv) n'keyo oel I kFk&I kFk f}vk/kjh i ¼fr dk Hk mi ; kx djrs gA
 mi jkDr i d fuka ea dks I s I R; gA
 - (a) oBoy (i) rFk (ii)
 - (b) oBoy (ii) rFk (iii) ,
 - (c) (i), (ii) rFk (iii) i jUrq (iv) ugha
 - (d) (i), (ii), (iii) rFk (iv) I Hk
- 15.4 n"Vj[; kh; I pkj oel fy, D; k ; g vko' ; d gSfd i kcd , w huk dh ÅpkbZ vfHkxtgh , w huk dh ÅpkbZ oel cjkj gk dkbZ TV i kcd , w huk 81 m Åpk gA ; fn vfHkxtgh , w huk Hkurj ij gsrks ; g fdrus {sk ea I ok; ; inku djsk\

- 15.5** 12 V f'k[kj okVrk dh okgd rjx dk mi ; l; fdl h l msk fl Xuy o; i; k. k o; fy, fd; k x; k g; ekMyu l pdkd 75% o; fy, ekMyd fl Xuy dh f'k[kj okVrk fdruh gskh pfg, ?
- 15.6** fpk 15.14 ean'k; vu; kj dk; ekMyd fl Xuy oxz rjx g;



fpk 15.14

fn; k x; k g; fdl okgd rjx $c(t) = 2 \sin(8\pi t)$ V

(i) vk; ke ekMyr rjx : i vk; f'k[kr dhft, A

(ii) ekMyu l pdkd D; k g;

- 15.7** fdl h ekMyr rjx dk vf/dre vk; ke 10V rFk U; ure vk; ke 2V ik; k tkrk g; ekMyu l pdkd μ dk eku fuf'pr dhft, A ; fn U; ure vk; ke 'k; okV g; r; ekMyu l pdkd D; k g; k;
- 15.8** vk; f'k[kr dk; k l fdl h AM rjx dk o; y; Åijh ik' o; z; gh i; f'k[kr fd; k tkrk g; i; j; r; q; x; gh LVS ku ij okgd rjx mRi Uu djus dh l f'k[kr g; ; g n'k; , fd ; fn dk; , d h ; f'k[kr mi y; / g; k; t; n; k; fl Xuy; dh x; k; k; dj l o; r; k; x; gh LVS ku ij ekMyd fl Xuy dh i; q; i; k; r; l k; k; o; g;