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exch round exch]setmatrix}N/@landscape{/isls true N}B/@manualfeed{
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sub Cy .1 sub]/id Ci N/rw Cw 7 add 8 idiv string N/rc 0 N/gp 0 N/cp 0 N{
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get A 0 eq{pop 128}{A 255 eq{pop 127}{A 2 idiv S 128 and or}ifelse}
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forall N/D{/cc X A type/stringtype ne{[]}if nn/base get cc ctr put nn
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SI restore userdict/eop-hook known{eop-hook}if showpage}N/@start{
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curveto}}{{closepath}}pathforall newpath counttomark array astore/gc xdf
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get ppr 1 get neg sub neg ppr 2 get ppr 0 get neg sub neg TR}if xflip
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90 rotate 1 -1 scale ppr 3 get ppr 1 get neg sub neg ppr 2 get ppr 0 get
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1415 y(1.5)33 b(hrs.)44 b(de)34 b(ejercicios)g(semanales)199
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2036 y Ff(1)550 2021 y Fj(+)23 b Fh(:::)e Fj(+)h Fh(x)911
2036 y Fe(n)966 2021 y Fg(j)27 b(\024)h(j)p Fh(x)1211
2036 y Ff(1)1255 2021 y Fg(j)22 b Fj(+)h Fh(:::)e Fj(+)i
Fg(j)p Fh(x)1695 2036 y Fe(n)1748 2021 y Fg(j)p Fh(:)315
2141 y Fj(-)51 b Fh(z)32 b Fg(\025)c Fj(0)33 b(y)g Fh(x)27
b Fg(\024)h Fh(y)i Fg(\))c Fh(xz)32 b Fg(\024)d Fh(y)t(z)t(:)315
2262 y Fj(-)51 b Fh(x)27 b Fg(\025)h Fj(0)33 b(e)h Fh(y)d
Fg(\024)d Fj(0)g Fg(\))f Fh(xy)k Fg(\024)d Fj(0)p Fh(:)315
2382 y Fj(-)51 b Fh(x)27 b Fg(\024)h Fj(0)33 b(e)h Fh(y)d
Fg(\024)d Fj(0)g Fg(\))f Fh(xy)k Fg(\025)d Fj(0)p Fh(:)315
2502 y Fj(-)51 b Fh(x)456 2465 y Ff(2)528 2502 y Fg(\025)28
b Fj(0)p Fh(:)28 2622 y Fj(iii\))48 b(El)33 b(conjun)m(to)i
Fh(Q)d Fj(de)i(los)f(n)s(\023)-53 b(umeros)34 b(racionales.)199
2741 y(Numerabilidad)42 b(de)i Fh(Q)p Fj(,)h(densidad)g(de)f
Fh(Q)f Fj(en)g Fh(I)-25 b(R)43 b Fj(\(en)m(tre)h(dos)g(reales)f
Fg(6)p Fj(=)i Fh(s)e Fj(ha)m(y)g(siempre)g(un)199 2861
y(racional\).)30 2981 y(iv\))49 b(Cota)34 b(Sup)s(erior,)h(Cota)f
(Inferior,)h(Supremo,)f(In\014mo,)g(M\023)-50 b(aximo)33
b(y)h(M)-11 b(\023)-39 b(\020nimo)33 b(de)i(una)g(parte)g(de)199
3100 y Fh(I)-25 b(R)p Fj(.)39 3342 y(3.-)49 b Fi(Sucesiones)37
b(en)g Fh(I)-25 b(R)p Fi(.)2381 b Fj(\(9,0)33 b(hrs.\))282
3584 y(i\))50 b(De\014nici\023)-50 b(on,)30 b(ejemplos)f(y)f(motiv)-6
b(aci\023)-50 b(on)27 b(de)j(las)f(sucesiones)h(en)g
Fh(I)-25 b(R)29 b Fj(Op)s(eraciones)h(con)f(suce-)399

3703 y(siones.)55 3823 y(ii\))49 b(De\014nici\023)-50
b(on)50 b(de)g(sucesi\023)-50 b(on)50 b(con)m(v)m(ergen)m(te)h(y)d(de)i
(pun)m(to)g(de)g(acum)m(ulaci\023)-50 b(on)48 b(de)i(una)g(sucesi\023)
-50 b(on.)199 3943 y(De\014nici\023)g(on)34 b(de)g(subsucesi\023)-50
b(on.)28 4063 y(iii\))48 b(Unicidad)34 b(del)f(l)-11
b(\023)-39 b(\020mite)31 b(de)j(una)g(sucesi\023)-50
b(on.)30 4183 y(iv\))49 b(T)-8 b(o)s(da)33 b(sucesi\023)-50
b(on)34 b(con)m(v)m(ergen)m(te)h(es)f(acotada.)58 4303
y(v\))49 b(T)-8 b(eorema)35 b(de)h(Bolzano-W)-8 b(eierstrass:)49
b(Si)36 b(\()p Fh(u)1911 4318 y Fe(k)1959 4303 y Fj(\))g(es)g(una)g
(sucesi\023)-50 b(on)37 b(en)f(un)h(in)m(terv)-6 b(alo)35
b([)p Fh(a;)17 b(b)p Fj(],)34 b(en-)199 4422 y(tonces)29
b(existe)g(al)e(menos)i(un)g(pun)m(to)g(de)g(acum)m(ulaci\023)-50
b(on)28 b(de)h(\()p Fh(u)2520 4437 y Fe(k)2568 4422 y
Fj(\))g(en)g([)p Fh(a;)17 b(b)p Fj(].)40 b(esto)28 b(es)h(equiv)-6
b(alen)m(te)199 4542 y(a)33 b(decir)h(que)f(\()p Fh(u)807
4557 y Fe(k)856 4542 y Fj(\))g(tiene)h(una)f(subsucesi\023)-50
b(on)36 b(con)m(v)m(ergen)m(te)f(en)f([)p Fh(a;)17 b(b)p
Fj(].)199 4662 y(Corolario:)40 b(T)-8 b(o)s(da)26 b(sucesi\023)-50
b(on)29 b(acotada)d(con)i(un)g(s\023)-50 b(olo)26 b(pun)m(to)i(de)g
(acum)m(ulaci\023)-50 b(on,)28 b(es)g(con)m(v)m(ergen)m(te.)30
4782 y(vi\))49 b(\()p Fh(u)295 4797 y Fe(k)344 4782 y
Fj(\))27 b Fg(!)h Fh(c;)17 b(v)674 4797 y Fe(k)750 4782
y Fj(=)28 b Fh(u)912 4797 y Fe(k)1061 4782 y Fg(8)p Fh(k)j
Fg(\025)d Fh(K)35 b Fg(\))27 b Fj(\()p Fh(v)1638 4797
y Fe(k)1687 4782 y Fj(\))g Fg(!)h Fh(c:)199 4901 y Fj(\()p
Fh(u)295 4916 y Fe(k)344 4901 y Fj(\))f Fg(!)h Fj(0)p
Fh(;)17 b Fg(j)p Fh(v)709 4916 y Fe(k)757 4901 y Fg(j)27
b(\024)h(j)p Fh(u)1002 4916 y Fe(k)1051 4901 y Fg(j)99
b(8)p Fh(k)31 b Fg(\025)e Fh(K)34 b Fg(\))27 b Fj(\()p
Fh(v)1755 4916 y Fe(k)1804 4901 y Fj(\))h Fg(!)f Fj(0)p
Fh(:)199 5021 y Fj(\()p Fh(u)295 5036 y Fe(k)344 5021
y Fj(\))g Fg(!)h Fh(c;)17 b Fj(\()p Fh(v)713 5036 y Fe(k)761
5021 y Fj(\))28 b Fg(!)h Fh(d;)17 b(u)1109 5036 y Fe(k)1185
5021 y Fg(\024)28 b Fh(v)1338 5036 y Fe(k)1487 5021 y
Fg(8)p Fh(k)j Fg(\025)d Fh(K)34 b Fg(\))28 b Fh(c)g Fg(\024)g
Fh(d:)3 5141 y Fj(vii\))48 b(Estudio)33 b(de)h(las)f(sucesiones:)46
b(\()p Fh(k)1454 5105 y Fd(\000)p Fe(a)1564 5141 y Fj(\))33
b(donde)i Fh(a)27 b Fg(2)h Fh(Q)2183 5156 y Ff(+)2249
5141 y Fh(;)17 b Fj(\()p Fh(k)2388 5105 y Fe(p)2433 5141
y Fh(;)g(r)2526 5105 y Fe(k)2574 5141 y Fj(\))33 b(donde)h
Fh(p)28 b Fg(2)g Fh(I)-25 b(N)44 b Fj(y)33 b Fg(j)p Fh(r)s
Fg(j)26 b Fh(<)i Fj(1.)1888 5380 y(2)p eop
%%Page: 3 3
3 2 bop -25 100 a Fj(viii\))48 b(L)-11 b(\023)-39 b(\020mite)44
b(de)j(la)e(suma,)i(del)f(pro)s(ducto)g(y)f(del)h(cuo)s(cien)m(te)h(de)
f(dos)g(sucesiones)h(con)m(v)m(ergen)m(tes.)199 219 y(itemix\))31
b(\()p Fh(u)641 234 y Fe(k)690 219 y Fj(\))g Fg(!)h Fj(0)p
Fh(;)17 b Fj(\()p Fh(v)1066 234 y Fe(k)1114 219 y Fj(\))33
b(acotada)g Fg(\))27 b Fj(\()p Fh(u)1780 234 y Fe(k)1829
219 y Fj(\))22 b Fg(\001)f Fj(\()p Fh(v)2026 234 y Fe(k)2075
219 y Fj(\))28 b Fg(!)f Fj(0.)58 343 y(x\))49 b(Criterio)33
b(del)g(cuo)s(cien)m(te)h(en)g(el)f(estudio)h(de)g(la)f(con)m(v)m
(ergencia.)30 487 y(xi\))49 b(Estudio)33 b(de)h(las)f(sucesiones:)46
b(\()1411 447 y Fe(k)1455 417 y Fc(p)p 1411 464 87 4
v 1411 522 a Fe(a)1454 502 y Fc(k)1510 487 y Fj(\))33
b(donde)h Fh(p)28 b Fg(2)g Fh(I)-25 b(N)43 b Fj(y)33
b Fh(a)27 b Fj(>)i Fj(1;)17 b(\()2607 447 y Fe(a)2650 417
y Fc(k)p 2605 464 V 2615 521 a Fe(k)r Ff(!)2704 487 y
Fj(\))33 b(donde)h Fh(a)28 b Fg(2)g Fh(I)-25 b(R)p Fj(.)3
611 y(xii\))48 b(T)-8 b(o)s(da)33 b(sucesi\023)-50 b(on)34
b(mon\023)-50 b(otona)32 b(y)h(acotada)g(es)h(con)m(v)m(ergen)m(te.)-25
803 y(xiii\))48 b(Estudio)33 b(de)h(las)f(sucesiones:)46
b(\()1441 709 y Fe(k)1411 729 y Fj(!)1411 891 y Fb(P)1399 891 y Fe(i)p

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(uidad)j(de)g(la)f(funci\023)-50 b(on)34 b(exp)s(onencial.)30
3927 y(iv\))49 b(F)-8 b(unciones)35 b(hip)s(erb\023)-50
b(olicas.)58 4051 y(v\))49 b(F)-8 b(unciones)40 b(trigonom)m(\023)-47
b(etricas.)57 b(propiedades)40 b(elemen)m(tales)e(de)g(las)g(funciones)
i(trigonom)m(\023)-47 b(etri-)199 4171 y(cas.)30 4295
y(vi\))49 b(T)-8 b(eorema)41 b(del)i(v)-6 b(alor)42 b(in)m(termedio:)61
b(Si)42 b Fh(I)50 b Fj(es)43 b(un)g(in)m(terv)-6 b(alo)42
b(en)h Fh(I)-25 b(R)42 b Fj(y)g(si)g Fh(f)53 b Fj(:)43
b Fh(I)50 b Fg(!)42 b Fh(I)-25 b(R)42 b Fj(es)h(una)199
4414 y(funci\023)-50 b(on)35 b(con)m(tin)m(ua,)e(en)m(tonces)i
Fh(f)11 b Fj(\()p Fh(I)d Fj(\))32 b(es)i(un)g(in)m(terv)-6
b(alo)33 b(en)g Fh(I)-25 b(R)p Fj(.)3 4538 y(vii\))48
b(El)36 b(rango)h(de)g(la)g(funci\023)-50 b(on)38 b(exp)s(onencial)f
(es)g Fh(I)-25 b(R)1979 4553 y Ff(+)2045 4538 y Fj(.)54
b(Existencia)37 b(de)g(una)g(soluci\023)-50 b(on)37 b(real)g(de)g(una)
199 4658 y(ecuaci\023)-50 b(on)36 b(c)s(\023)-53 b(ubica.)48
b(T)-8 b(eorema)33 b(del)i(pun)m(to)g(\014jo:)47 b Fh(f)40
b Fj(:)30 b([0)p Fh(;)17 b Fj(1])28 b Fg(!)h Fj([0)p
Fh(;)17 b Fj(1])33 b(es)i(una)f(funci\023)-50 b(on)36
b(con)m(tin)m(ua,)199 4777 y(en)m(tonces)f(existe)e Fh(c)28
b Fg(2)g Fj([0)p Fh(;)17 b Fj(1])31 b(tal)i(que)g Fh(f)11
b Fj(\()p Fh(c)p Fj(\))27 b(=)h Fh(c:)-25 4902 y Fj(viii\))48
b(T)-8 b(eorema:)75 b(si)50 b Fh(f)65 b Fj(:)54 b Fh(D)k
Fg(!)d Fh(I)-25 b(R)49 b Fj(es)h(una)g(funci\023)-50
b(on)50 b(con)m(tin)m(ua)h(y)e(si)g Fh(c)55 b Fg(2)g
Fh(D)e Fj(es)d(un)g(pun)m(to)g(de)199 5021 y(acum)m(ulaci\023)-50
b(on)34 b(de)g(una)h(sucesi\023)-50 b(on)35 b(\()p Fh(x)1586
5036 y Fe(k)1635 5021 y Fj(\))e(en)i Fh(D)s Fj(,)f(en)m(tonces)i
Fh(f)11 b Fj(\()p Fh(c)p Fj(\))33 b(es)h(un)h(pun)m(to)f(de)h(acum)m
(ulaci\023)-50 b(on)199 5141 y(de)34 b(la)f(sucesi\023)-50
b(on)34 b(\()p Fh(f)11 b Fj(\()p Fh(x)1026 5156 y Fe(k)1074
5141 y Fj(\)\).)1888 5380 y(3)p eop
%%Page: 4 4
4 3 bop 30 100 a Fj(ix\))49 b(T)-8 b(eorema:)40 b(Si)28
b Fh(f)39 b Fj(:)27 b([)p Fh(a;)17 b(b)p Fj(])26 b Fg(!)h
Fh(I)-25 b(R)28 b Fj(es)g(una)h(funci\023)-50 b(on)29
b(con)m(tin)m(ua,)g(en)m(tonces)h Fh(f)11 b Fj(\([)p
Fh(a;)17 b(b)p Fj(]\))25 b(es)j(un)h(in)m(terv)-6 b(alo)199
219 y(acotado)33 b(en)h Fh(I)-25 b(R)p Fj(.)58 339 y(x\))49
b(T)-8 b(eorema:)42 b(Si)31 b Fh(f)38 b Fj(:)28 b([)p
Fh(a;)17 b(b)p Fj(])25 b Fg(!)j Fh(I)-25 b(R)30 b Fj(es)i(con)m(tin)m
(ua)g(en)m(tonces)h Fh(f)41 b Fj(tiene)31 b(un)h(m\023)-50
b(aximo)28 b(y)j(un)g(m)-11 b(\023)-39 b(\020nimo)29
b(en)199 458 y(el)35 b(in)m(terv)-6 b(alo)34 b([)p Fh(a;)17
b(b)p Fj(],)33 b(esto)h(equiv)-6 b(ale)35 b(a)f(decir)h(que)g
Fh(f)11 b Fj([)p Fh(a;)17 b(b)p Fj(])32 b(es)j(un)h(in)m(terv)-6
b(alo)34 b(cerrado)h(y)f(acotado)199 578 y(en)g Fh(I)-25
b(R)p Fj(.)30 697 y(xi\))49 b(T)-8 b(eorema:)41 b(Si)29
b Fh(I)36 b Fj(es)30 b(un)f(in)m(terv)-6 b(alo)29 b(en)g
Fh(I)-25 b(R)29 b Fj(y)f(si)h Fh(f)38 b Fj(:)28 b Fh(I)35
b Fg(!)27 b Fh(I)-25 b(R)29 b Fj(es)h(una)f(funci\023)-50
b(on)30 b(con)m(tin)m(ua)g(in)m(y)m(ectiv)-6 b(a)199
817 y(en)m(tonces:)260 936 y(a\))50 b Fh(f)43 b Fj(es)34
b(mon\023)-50 b(otona.)255 1056 y(b\))50 b Fh(f)459 1020
y Fd(\000)p Ff(1)565 1056 y Fj(:)44 b(rango)33 b(\()p
Fh(f)11 b Fj(\))27 b Fg(!)g Fh(I)-25 b(R)33 b Fj(es)h(con)m(tin)m(ua)g
(y)f(mon\023)-50 b(otona.)3 1176 y(xii\))48 b(La)j(funci\023)-50
b(on)52 b Fh(`n)j Fj(:)i Fh(I)-25 b(R)1067 1191 y Ff(+)1190
1176 y Fg(!)56 b Fh(I)-25 b(R)51 b Fj(es)g(con)m(tin)m(ua)g(y)f
(mon\023)-50 b(otona.)95 b(In)m(v)m(ersas)51 b(de)h(las)e(funciones)199
1295 y(trigonom)m(\023)-47 b(etricas.)-25 1415 y(xiii\))48
b(de\014nici\023)-50 b(on)30 b(de)e(la)g(funci\023)-50
b(on)29 b Fh(f)11 b Fj(\()p Fh(x)p Fj(\))27 b(=)h Fh(a)1602
1379 y Fe(x)1652 1415 y Fj(,)h(con)f Fh(a)g(>)g Fj(0,)h(median)m(te)f
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...la fórmula

$$a^{x} = \exp(x\,\ln a)$$

Es una función continua creciente. Estudio de $f_{1}: I \to \mathbb{R}^{+}$, $\ldots$, obtención de la fórmula

$$f^{-1}(y) = \ldots$$

la función $f$ se denota usualmente por $\exp$ $\ldots$ y la función $f^{-1}$ por $\log a$ $\ldots$

(xiv) estudio de la función $f(x) = x^{b}$, con $b \in \mathbb{R}$.

(xv) Caracterización de la continuidad (sin uso de sucesiones:) $f: D \to \mathbb{R}$ es continua en $c \in D$ si y solo si para todo intervalo de la forma $[f(c) - \varepsilon,\ f(c) + \varepsilon]$ (con $\varepsilon > 0$), existe un intervalo de la forma $[c - \delta,\ c + \delta]$ (con $\delta > 0$) tal que $f([c - \delta,\ c + \delta] \cap D) \subset [f(c) - \varepsilon,\ f(c) + \varepsilon]$ o dicho en otras palabras, si y solo si para todo $\varepsilon > 0$ existe un $\delta > 0$ tal que $x \in D;\ |c - x| \le \delta \Rightarrow |f(c) - f(x)| \le \varepsilon$.

5.- Límite de Funciones (3,0 hrs.)

(i) Definición de punto interior y punto adherente de una parte de $\mathbb{R}$. Caracterización de punto adherente mediante sucesiones.

(ii) Definición de conjunto abierto, de conjunto cerrado, de interior y de adherencia (o cerradura) de una parte de $\mathbb{R}$.

(iii) Dada una función $f: d \to \mathbb{R}$ y un punto $c \in \bar{D}$ ($\bar{D}$ designa la adherencia del conjunto $D$), se dice que $\ell$ es el límite de $f(x)$ cuando $x$ tiende a $c$ si para toda sucesión $(f(x_{k}))$ converge a $\ell = \lim_{x \to c} f(x)$.

(iv) Una función $f: D \to \mathbb{R}$ es continua en $c \in D$ si y solo si $\lim$

3867 y Fe(x)p Fd(!)p Fe(c)2874 3807 y Fh(f)11 b Fj(\()p
Fh(x)p Fj(\))27 b(=)h Fh(f)11 b Fj(\()p Fh(c)p Fj(\).)58
3962 y(v\))49 b(De\014nici\023)-50 b(on)34 b(de)g(l)-11
b(\023)-39 b(\020mite)31 b(p)s(or)j(la)e(derec)m(ha)j(y)e(p)s(or)g(la)g
(izquierda.)30 4081 y(vi\))49 b(Caracterizaci\023)-50
b(on)42 b(del)h(l)-11 b(\023)-39 b(\020mite)40 b(sin)j(uso)g(de)g
(sucesiones:)64 b Fh(\013)42 b Fj(es)h(el)f(l)-11 b(\023)-39
b(\020mite)40 b(de)j Fh(f)11 b Fj(\()p Fh(x)p Fj(\))41
b(cuando)j Fh(x)199 4201 y Fj(tiende)35 b(a)e Fh(c)c
Fg(2)772 4176 y Fj(\026)748 4201 y Fh(D)37 b Fj(si)d(y)f(solo)g(si)h
(para)g(to)s(do)f(in)m(terv)-6 b(alo)33 b(de)h(la)g(forma)e([)p
Fh(\013)23 b Fg(\000)g Fh(\017;)17 b(\013)22 b Fj(+)h
Fh(\017)p Fj(])33 b(\(con)h Fh(\017)29 b(>)g Fj(0\))199
4320 y(existe)e(un)g(in)m(terv)-6 b(alo)27 b(de)g(la)f(forma)g([)p
Fh(c)9 b Fg(\000)g Fh(\016)n(;)17 b(c)9 b Fj(+)g Fh(\016)t
Fj(])28 b(tal)e(que)h Fh(f)11 b Fj(\([)p Fh(c)e Fg(\000)g
Fh(\016)n(;)17 b(c)9 b Fj(+)g Fh(\016)t Fj(])g Fg(\\)g
Fh(D)s Fj(\))29 b Fg(\032)f Fj([)p Fh(\013)10 b Fg(\000)f
Fh(\017;)17 b(\013)10 b Fj(+)f Fh(\017)p Fj(])27 b(o)199
4440 y(escrito)g(de)h(otro)e(mo)s(do:)40 b(si)27 b(y)g(solo)f(si)h
(para)g(to)s(do)g Fh(\017)h(>)g Fj(0)f(existe)g Fh(\016)k(>)e
Fj(0)d(tal)h(que)g Fh(x)g Fg(2)i Fh(D)s(;)17 b Fg(j)p
Fh(c)10 b Fg(\000)g Fh(x)p Fg(j)26 b(\024)199 4560 y
Fh(\016)35 b Fg(\))30 b(j)p Fh(\013)24 b Fg(\000)f Fh(f)11
b Fj(\()p Fh(x)p Fj(\))p Fg(j)p Fh(\017)p Fj(.)49 b(Dar)35
b(una)g(caracterizaci\023)-50 b(on)36 b(an\023)-50 b(aloga)34
b(para)h(los)g(l)-11 b(\023)-39 b(\020mites)33 b(p)s(or)i(la)f(derec)m
(ha)j(y)199 4679 y(p)s(or)c(la)g(izquierda.)3 4799 y(vii\))48
b(L)-11 b(\023)-39 b(\020mite)38 b(de)h(una)g(suma,)g(de)g(un)g(pro)s
(ducto,)i(de)e(un)g(cuo)s(cien)m(te)h(y)e(de)h(la)f(comp)s(osici\023)
-50 b(on)38 b(de)h(dos)199 4918 y(funciones.)39 5141
y(6.-)49 b Fi(F)-10 b(unciones)38 b(Uniformemen)m(te)e(Con)m(tin)m(uas)
1446 b Fj(\(1,0)33 b(hr\))1888 5380 y(4)p eop
%%Page: 5 5
5 4 bop 83 100 a Fj(i\))49 b(De\014nici\023)-50 b(on)34
b(de)g(con)m(tin)m(uidad)h(uniforme.)55 219 y(ii\))49
b(teorema:)56 b(Si)40 b Fh(f)49 b Fj(:)38 b([)p Fh(a;)17
b(b)p Fj(])36 b Fg(!)i Fh(I)-25 b(R)40 b Fj(es)g(una)g(funci\023)-50
b(on)41 b(con)m(tin)m(ua,)h(en)m(tonces)f Fh(f)51 b Fj(es)40
b(uniformemen)m(te)199 339 y(con)m(tin)m(ua.)28 458 y(iii\))48
b(Suma)33 b(y)g(pro)s(ducto)g(de)h(dos)g(funciones)h(uniformemen)m(te)e
(con)m(tin)m(uas.)39 696 y(7.-)49 b Fi(Sucesiones)37
b(de)g(F)-10 b(unciones)2016 b Fj(\(3,0)33 b(hrs.\))83
935 y(i\))49 b(Con)m(v)m(ergencia)35 b(simple)e(\(o)g(pun)m(tual\))h(y)
g(uniforme)f(de)i(una)f(sucesi\023)-50 b(on)35 b(de)g(funciones)g
(de\014nidas)199 1054 y(en)f(una)g(parte)f Fh(D)k Fj(de)d
Fh(I)-25 b(R)o Fj(.)55 1174 y(ii\))49 b(T)-8 b(eorema:)44
b(si)34 b(\()p Fh(f)f Fj(835 1189 y Fe(k)884 1174 y Fj(\))f(es)i(una)f
(sucesi\023)-50 b(on)35 b(de)g(funciones)h(con)m(tin)m(uas)f(\(resp.)46
b(uniformemen)m(te)34 b(con-)199 1293 y(tin)m(uas\))39
b(con)m(v)m(ergen)m(te)h(uniformemen)m(te)e(a)g(una)h(funci\023)-50
b(on)40 b Fh(f)11 b Fj(,)39 b(en)m(tonces)h Fh(f)49 b
Fj(es)39 b(con)m(tin)m(ua)g(\(resp.)199 1413 y(uniformemen)m(te)33
b(con)m(tin)m(ua\).)28 1532 y(iii\))48 b(T)-8 b(eorema:)54
b(una)39 b(condici\023)-50 b(on)40 b(necesaria)f(y)g(su\014cien)m(te)h
(para)f(que)g(una)g(sucesi\023)-50 b(on)40 b(de)g(funciones)199
1652 y(\()p Fh(f)f Fj(287 1667 y Fe(k)336 1652 y Fj(\))46
b(con)m(v)m(erja)h(uniformemen)m(te)f(a)g(una)g(funci\023)-50
b(on)48 b Fh(f)56 b Fj(es)47 b(que)f(para)h(to)s(do)e
Fh(\017)50 b(>)g Fj(0)45 b(exista)h(un)199 1772 y(natural)33
b Fh(K)40 b Fj(tal)33 b(que)g Fg(j)p Fh(f)1085 1787 y
Fe(i)1118 1772 y Fj(\()p Fh(x)p Fj(\))21 b Fg(\000)i
Fh(f)1423 1787 y Fe(j)1465 1772 y Fj(\()p Fh(x)p Fj(\))p
Fg(j)p Fh(\017)p Fj(,)39 b(en)m(tonces)h Fh(f)49 b Fj(es)39
Fg(j)p Fh(\024)j Fh(\017)k Fj(para)g(to)s(do)g Fh(x)28 b

... $\in D$ y todo $i;\, j \ge K$.

(iv) Polinomio de Bernstein de orden $n$ asociado a una función continua $f : [0,1] \to \mathbb{R}$ y Teorema de Weierstrass.

## 8.- Series de $\mathbb{R}$ (3,0 hrs.)

(i) Definición de una serie como sucesión de sumas parciales, suma de dos series y producto de una serie por un escalar.

(ii) Series convergentes. Convergencia de la suma de dos series convergentes. Convergencia del producto de una serie convergente por un escalar.

(iii) Toda serie de números positivos y acotada es convergente.

(iv) Series absolutamente convergentes. Toda serie absolutamente convergente es convergente.

(v) Algunos criterios de convergencia:

- si $\sum u_k$ es convergente y si $|v_k| \le C\,u_k$ $\forall k \ge K$, entonces $\sum v_k$ es absolutamente convergente.
- si existe $r \in {]}0;1{[}$ tal que $|u_{k+1}| \le r\,|u_k|$ $\forall k \ge K$, entonces $\sum u_k$ es absolutamente convergente.
- si existe $r \in {]}0;1{[}$ tal que $\sqrt[k]{|u_k|} \le r$, entonces $\sum u_k$ es absolutamente convergente.
- si $(u_k)$ es una sucesión monótona decreciente convergente a cero, entonces $\sum (-1)^{k-1} u_k$ es convergente (no necesariamente absolutamente convergente).

(vi) $\exp(x) = 1 + \displaystyle\sum_{k=1}^{\infty} \frac{x^k}{k!}$.

## 9.- Derivación de Funciones. (15,0 hrs.)

(i) Definición: Una función $f : D \to \mathbb{R}$ se dice derivable (o diferenciable) en un punto $a \in \overset{\circ}{D}$ (interior del conjunto $D$) si existe un número $d$ tal que $\lim_{x \to a} f_a(x) = d$ donde

eop
%%Page: 6 6

6 5 bop 199 101 a Fh(f)248 116 y Fe(a)323 101 y Fj(es)27
b(la)f(funci\023)-50 b(on)28 b(de\014nida)g(en)f Fh(D)12
b Fg(n)d(f)p Fh(a)p Fg(g)25 b Fj(p)s(or)i(la)f(igualdad)g
Fh(f)2433 116 y Fe(a)2481 101 y Fj(\()p Fh(x)p Fj(\))h(=)2761
52 y Fe(f)8 b Ff(\()p Fe(x)p Ff(\))p Fd(\000)p Fe(f)g
Ff(\()p Fe(a)p Ff(\))p 2761 78 369 4 v 2869 135 a Fe(x)p
Fd(\000)p Fe(a)3141 101 y Fj(.)42 b(In)m(terpretaci\023)-50
b(on)199 220 y(geom)m(\023)j(etrica)39 b(del)h(n)s(\023)-53
b(umero)39 b Fh(d)h Fj(que)g(se)g(llamar\023)-50 b(a)37
b(deriv)-6 b(ada)41 b(de)f(la)f(funci\023)-50 b(on)41
b Fh(f)50 b Fj(en)41 b(el)e(pun)m(to)i Fh(a)e Fj(y)199
340 y(se)48 b(denotar\023)-50 b(a)47 b(p)s(or)g Fh(f)1013
304 y Fd(0)1041 340 y Fj(\()p Fh(a)p Fj(\).)85 b(Estudio)47
b(del)g(crecimien)m(to)g(y)g(decrecimien)m(to)g(de)h(una)g(funci\023)
-50 b(on.)199 459 y(Apro)m(ximaci\023)g(on)32 b(lineal)g(de)i(una)g
(funci\023)-50 b(on)34 b(en)g(un)g(pun)m(to.)55 588 y(ii\))49
b(La)34 b(funci\023)-50 b(on)34 b(deriv)-6 b(ada)34 b(de)f(una)h
(funci\023)-50 b(on)35 b Fh(f)11 b Fj(.)28 716 y(iii\))48
b(T)-8 b(eorema:)74 b(Una)49 b(funci\023)-50 b(on)50
b Fh(f)64 b Fj(:)53 b Fh(D)k Fg(!)c Fh(I)-25 b(R)48 b
Fj(es)h(deriv)-6 b(able)50 b(en)f Fh(a)k Fg(2)h(\016)p
Fh(D)e Fj(si)d(y)f(solo)g(si)h(existe)199 836 y(un)d(n)s(\023)-53
b(umero)44 b Fh(d)h Fj(y)f(una)i(funci\023)-50 b(on)46
b Fh(\022)j Fj(:)e([)p Fh(a)29 b Fg(\000)i Fh(\016)n(;)17
b(a)29 b Fj(+)h Fh(\016)t Fj(])47 b Fg(!)g Fh(I)-25 b(R)44
b Fj(\(con)h Fh(\016)51 b(>)d Fj(0\))c(tal)g(que)h Fh(f)11
b Fj(\()p Fh(x)p Fj(\))46 b(=)199 955 y Fh(f)11 b Fj(\()p
Fh(a)p Fj(\))21 b(+)i Fh(d)p Fj(\()p Fh(x)e Fg(\000)i
Fh(a)p Fj(\))f(+)g(\()p Fh(x)g Fg(\000)h Fh(a)p Fj(\))p
Fh(\022)s Fj(\()p Fh(x)p Fj(\))31 b(para)i(to)s(do)g
Fh(x)28 b Fg(2)g Fj([)p Fh(a)21 b Fg(\000)i Fh(\016)n(;)17
b(a)k Fj(+)i Fh(\016)t Fj(])33 b(y)g(adem\023)-50 b(as)47
b(lim)3168 1015 y Fe(x)p Fd(!)p Fe(a)3352 955 y Fh(\022)s
Fj(\()p Fh(x)p Fj(\))27 b(=)h(0.)30 1119 y(iv\))49 b(Deriv)-6
b(ada)34 b(de)f(una)h(funci\023)-50 b(on)35 b(p)s(olinomial.)58
1247 y(v\))49 b(T)-8 b(eorema:)43 b(si)33 b Fh(f)44 b
Fj(es)34 b(deriv)-6 b(able,)33 b(en)h(un)g(pun)m(to)g(ella)f(es)g(con)m
(tin)m(ua)h(en)g(ese)g(pun)m(to.)30 1375 y(vi\))49 b(Deriv)-6
b(ada)34 b(de)f(la)g(suma,)f(del)i(pro)s(ducto)g(y)e(del)i(cuo)s(cien)m
(te)g(de)g(dos)g(funciones)h(deriv)-6 b(ables.)3 1504
y(vii\))48 b(Regla)33 b(de)h(la)f(cadena:)45 b(deriv)-6
b(ada)33 b(de)h(la)f(comp)s(osici\023)-50 b(on)32 b(de)i(dos)g
(funciones)h(deriv)-6 b(ables.)-25 1632 y(viii\))48 b(Deriv)-6
b(ada)34 b(de)f(la)g(funci\023)-50 b(on)35 b(in)m(v)m(ersa)e(de)h(una)g
(funci\023)-50 b(on)34 b(in)m(y)m(ectiv)-6 b(a.)30 1761
y(ix\))49 b(Deriv)-6 b(ada)34 b(de)f(la)g(funci\023)-50
b(on)35 b Fh(exp;)17 b(`n;)g(exp)1715 1776 y Fe(a)1762
1761 y Fh(y)t(Log)1979 1776 y Fe(a)2026 1761 y Fj(.)58
1889 y(x\))49 b(Deriv)-6 b(ada)34 b(de)f(las)g(funciones)i
Fh(f)11 b Fj(\()p Fh(x)p Fj(\))27 b(=)h Fh(x)1723 1853
y Fe(r)1767 1889 y Fj(,)33 b(con)h Fh(r)c Fg(2)e Fh(I)-25
b(R)p Fj(.)30 2018 y(xi\))49 b(Deriv)-6 b(ada)34 b(de)f(las)g
(funciones)i(trigonom)m(\023)-47 b(etricas)32 b(y)h(sus)h(in)m(v)m
(ersas.)3 2146 y(xii\))48 b(T)-8 b(eorema)27 b(del)h(v)-6
b(alor)27 b(medio:)41 b(Dada)28 b(una)g(funci\023)-50
b(on)29 b Fh(f)38 b Fj(:)28 b([)p Fh(a;)17 b(b)p Fj(])25
b Fg(!)j Fh(I)-25 b(R)27 b Fj(deriv)-6 b(able,)29 b(en)m(tonces)h
(existe)199 2282 y(un)k(pun)m(to)g Fh(t)28 b Fg(2)p Fj(])p
Fh(a;)17 b(b)p Fj([)32 b(tal)g(que)h Fh(f)1381 2245 y
Fd(0)1409 2282 y Fj(\()p Fh(t)p Fj(\))27 b(=)1667 2233
y Fe(f)8 b Ff(\()p Fe(b)p Ff(\))p Fd(\000)p Fe(f)g Ff(\()p
Fe(a)p Ff(\))p 1667 2259 359 4 v 1776 2316 a Fe(b)p Fd(\000)p
Fe(a)2037 2282 y Fj(.)199 2401 y(Corolario:)42 b(Dada)31
b(una)h(funci\023)-50 b(on)33 b Fh(f)38 b Fj(:])p Fh(a;)17

b(b)p Fj([)p Fg(!)25 b Fh(I)-25 b(R)31 b Fj(deriv)-6
b(able,)32 b(si)g(la)e(funci\023)-50 b(on)33 b Fh(f)3109
2365 y Fd(0)3168 2401 y Fj(es)f(n)m(ula)g(en)g(])p Fh(a;)17
b(b)p Fj([)199 2521 y(en)m(tonces)35 b Fh(f)44 b Fj(es)34
b(una)f(funci\023)-50 b(on)35 b(constan)m(te)f(en)g(])p
Fh(a;)17 b(b)p Fj([.)-25 2649 y(xiii\))48 b(Condici\023)-50
b(on)33 b(necesaria)h(de)f(los)g(pun)m(tos)h(m\023)-50
b(aximos)30 b(y)i(m)-11 b(\023)-39 b(\020nimos)31 b(de)i(una)g
(funci\023)-50 b(on)34 b(deriv)-6 b(able:)45 b(Si)199
2769 y Fh(f)g Fj(:)34 b Fh(D)k Fg(!)33 b Fh(I)-25 b(R)37
b Fj(es)h(deriv)-6 b(able)38 b(y)f(si)g Fh(c)d Fg(2)h(\016)p
Fh(D)40 b Fj(es)e(un)g(m\023)-50 b(aximo)34 b(o)j(m)-11
b(\023)-39 b(\020nimo)35 b(de)i Fh(f)48 b Fj(en)38 b
Fh(D)s Fj(,)g(en)m(tonces)199 2888 y Fh(f)259 2852 y
Fd(0)287 2888 y Fj(\()p Fh(c)p Fj(\))j(=)g(0.)69 b(Esta)41
b(misma)e(condici\023)-50 b(on)42 b(es)g(v\023)-50 b(alida)40
b(si)i Fh(c)f Fj(es)h(un)g(m\023)-50 b(aximo)38 b(lo)s(cal)j(o)g(un)h
(m)-11 b(\023)-39 b(\020nimo)199 3008 y(lo)s(cal.)43
b(De\014nici\023)-50 b(on)34 b(de)g(pun)m(to)g(de)g(in\015exi\023)-50
b(on.)-22 3136 y(xiv\))48 b(F)-8 b(unciones)32 b(con)m(v)m(exas.)43
b(Caracterizaci\023)-50 b(on)30 b(de)h(la)f(con)m(v)m(exidad)h(median)m
(te)f(el)g(uso)h(de)g(la)e(funci\023)-50 b(on)199 3256
y(deriv)-6 b(ada.)45 b(Condici\023)-50 b(on)33 b(su\014cien)m(te)i(de)f
(pun)m(to)g(m)-11 b(\023)-39 b(\020nimo)31 b(de)j(una)f(funci\023)-50
b(on)35 b(con)m(v)m(exa.)6 3384 y(xv\))48 b(F)-8 b(unci\023)-50
b(on)42 b(dos)f(v)m(eces)h(deriv)-6 b(able)42 b(y)f(deriv)-6
b(ada)41 b(de)h(segundo)g(orden)g(en)g(un)g(pun)m(to.)68
b(T)-8 b(eorema:)199 3504 y(Una)30 b(funci\023)-50 b(on)31
b Fh(f)38 b Fj(:)28 b Fh(D)i Fg(!)e Fh(I)-25 b(R)29 b
Fj(ser\023)-50 b(a)31 b(dos)f(v)m(eces)h(deriv)-6 b(able)30
b(en)g(un)h(pun)m(to)g Fh(a)c Fg(2)h(\016)p Fh(D)33 b
Fj(si)d(y)f(solo)g(si)h(ella)199 3623 y(es)35 b(deriv)-6
b(able)35 b(en)g Fh(a)g Fj(y)f(existe)g(un)h(n)s(\023)-53
b(umero)35 b Fh(s)f Fj(y)g(una)h(funci\023)-50 b(on)36
b Fh(\022)c Fj(:)e([)p Fh(a)22 b Fg(\000)h Fh(\016)n(;)17
b(a)23 b Fj(+)g Fh(\016)t Fj(])30 b Fg(!)f Fh(I)-25 b(R)35
b Fj(tal)e(que)199 3743 y Fh(f)11 b Fj(\()p Fh(x)p Fj(\))28
b(=)g Fh(f)11 b Fj(\()p Fh(a)p Fj(\))22 b(+)g Fh(f)899
3707 y Fd(0)927 3743 y Fj(\()p Fh(a)p Fj(\)\()p Fh(x)f
Fg(\000)i Fh(a)p Fj(\))f(+)1501 3704 y Ff(1)p 1501 3720
40 4 v 1501 3777 a(2)1553 3743 y Fj(\()p Fh(x)g Fg(\000)h
Fh(a)p Fj(\))1863 3707 y Ff(2)1907 3743 y Fh(s)f Fj(+)h(\()p
Fh(x)f Fg(\000)h Fh(a)p Fj(\))2386 3707 y Ff(2)2430 3743
y Fh(\022)s Fj(\()p Fh(x)p Fj(\))32 b(para)i(to)s(do)f
Fh(x)c Fg(2)f Fj([)p Fh(a)22 b Fg(\000)h Fh(\016)n(;)17
b(a)22 b Fj(+)h Fh(\016)t Fj(])199 3863 y(y)31 b(adem\023)-50
b(as)45 b(lim)635 3922 y Fe(x)p Fd(!)p Fe(a)820 3863
y Fh(\022)s Fj(\()p Fh(x)p Fj(\))26 b(=)j(0.)43 b(In)m(terpretaci\023)
-50 b(on)31 b(geom\023)-47 b(etrica)30 b(de)i(la)e(deriv)-6
b(ada)31 b(de)h(segundo)g(orden:)199 4011 y(conca)m(vidad)i(de)g(una)g
(funci\023)-50 b(on,)34 b(apro)m(ximaci\023)-50 b(on)31
b(cuadr\023)-50 b(atica)34 b(de)f(una)h(funci\023)-50
b(on)35 b(en)f(un)f(pun)m(to.)-22 4140 y(xvi\))48 b(La)34
b(funci\023)-50 b(on)34 b(deriv)-6 b(ada)34 b(de)f(segundo)i(orden)f
(de)g(una)f(funci\023)-50 b(on)35 b Fh(f)11 b Fj(.)-50
4268 y(xvii\))48 b(Caracterizaci\023)-50 b(on)35 b(de)h(la)e(con)m(v)m
(exidad)i(de)g(una)f(funci\023)-50 b(on)37 b(median)m(te)e(el)g(uso)g
(de)h(la)f(deriv)-6 b(ada)35 b(de)199 4388 y(segundo)g(orden.)-77
4516 y(xviii\))47 b(Condiciones)35 b(necesarias)h(y)e(su\014cien)m(tes)
i(de)f(m\023)-50 b(aximos)32 b(y)i(m)-11 b(\023)-39 b(\020nimos)32
b(lo)s(cales)i(median)m(te)g(el)g(uso)199 4636 y(de)g(la)f(deriv)-6
b(ada)33 b(de)h(segundo)h(orden.)-22 4764 y(xix\))48
b(Regla)33 b(de)h(l'H\^)-50 b(opital)32 b(para)h(el)g(c\023)-50
b(alculo)33 b(del)h(l)-11 b(\023)-39 b(\020mite)31 b(de)j(un)g(cuo)s

(cien)m(te)g(de)g(funciones.)6 4893 y(xx\))48 b(Deriv)-6
b(adas)34 b(de)g(orden)g(sup)s(erior)f(y)g(desarrollo)g(de)h(T)-8
b(a)m(ylor.)-50 5021 y(xxii\))48 b(M)m(\023)-47 b(eto)s(do)42
b(de)g(Newton)f(para)h(la)f(apro)m(ximaci\023)-50 b(on)40
b(del)i(m)-11 b(\023)-39 b(\020nimo)39 b(de)j(una)g(funci\023)-50
b(on)43 b(y)e(la)g(apro)m(xi-)199 5141 y(maci\023)-50
b(on)32 b(de)i(las)f(ra)-11 b(\023)-39 b(\020ces)34 b(de)g(una)f
(ecuaci\023)-50 b(on.)1888 5380 y(6)p eop
%%Page: 7 7
7 6 bop -11 100 a Fj(10.-)49 b Fi(In)m(tegraci\023)-57
b(on.)2580 b Fj(\(20,0)32 b(hrs.\))83 337 y(i\))49 b(In)m(tegral)39
b(de)g(Riemann)g(de)g(una)h(funci\023)-50 b(on)40 b(acotada)e
(de\014nida)i(en)f(un)h(in)m(terv)-6 b(alo)38 b([)p Fh(a;)17
b(b)p Fj(].)59 b(In)m(ter-)199 456 y(pretaci\023)-50
b(on)34 b(geom)m(\023)-47 b(etrica)32 b(\(de\014nici\023)-50
b(on)34 b(de)g(Area\))e(e)i(in)m(terpretaci\023)-50 b(onf)-11
b(\023)-39 b(\020sica.)45 b(Algunos)33 b(ejemplos.)55
576 y(ii\))49 b(T)-8 b(o)s(da)33 b(funci\023)-50 b(on)34
b(con)m(tin)m(ua)g(p)s(or)g(tramos)e(en)i([)p Fh(a;)17
b(b)p Fj(])31 b(es)j(in)m(tegrable.)44 b(T)-8 b(o)s(da)33
b(funci\023)-50 b(on)34 b(mon\023)-50 b(otona)32 b(y)199
695 y(acotada)h(en)h([)p Fh(a;)17 b(b)p Fj(])31 b(es)j(in)m(tegrable.)
28 815 y(iii\))48 b(De\014nici\023)-50 b(on)47 b(de)f(la)g(in)m(tegral)
f(en)m(tre)i Fh(b)e Fj(y)g Fh(a)h Fj(cuando)h Fh(a)h(>)h(b)p
Fj(.)81 b(In)m(tegral)46 b(de)g(la)g(suma)f(de)h(dos)199
934 y(funciones)35 b(y)e(del)h(pro)s(ducto)f(de)h(una)g(funci\023)-50
b(on)34 b(p)s(or)f(un)h(escalar.)30 1054 y(iv\))49 b(Propiedades)41
b(de)f(la)f(in)m(tegral:)56 b(Si)40 b Fh(f)50 b Fj(y)39
b Fh(g)k Fj(son)d(dos)g(funciones)h(in)m(tegrables)g(en)f(un)g(in)m
(terv)-6 b(alo)199 1174 y([)p Fh(a;)17 b(b)p Fj(])32
b(se)h(tendr\023)-50 b(a)1311 1267 y Fe(c)1257 1287 y
Fb(Z)1263 1568 y Fe(a)1373 1422 y Fh(f)11 b Fj(\()p Fh(x)p
Fj(\))p Fh(dx)21 b Fj(+)1852 1267 y Fe(b)1797 1287 y
Fb(Z)1807 1568 y Fe(c)1914 1422 y Fh(f)11 b Fj(\()p Fh(x)p
Fj(\))p Fh(dx)26 b Fj(=)2404 1267 y Fe(b)2349 1287 y
Fb(Z)2355 1568 y Fe(a)2465 1422 y Fh(f)11 b Fj(\()p Fh(x)p
Fj(\))p Fh(dx)875 1869 y Fj(\()p Fh(b)21 b Fg(\000)i
Fh(a)p Fj(\))78 b(inf)1187 1938 y Fe(x)p Fd(2)p Ff([)p
Fe(a;b)p Ff(])1449 1869 y Fh(f)11 b Fj(\()p Fh(x)p Fj(\))26
b Fg(\024)1830 1714 y Fe(b)1775 1734 y Fb(Z)1781 2015
y Fe(a)1892 1869 y Fh(f)11 b Fj(\()p Fh(x)p Fj(\))p Fh(dx)26
b Fg(\024)i Fj(\()p Fh(b)22 b Fg(\000)g Fh(a)p Fj(\))g
Fg(\001)70 b Fj(sup)2694 1958 y Fe(x)p Fd(2)p Ff([)p
Fe(a;b)p Ff(])2956 1869 y Fh(f)11 b Fj(\()p Fh(x)p Fj(\))766
2316 y Fh(g)t Fj(\()p Fh(x)p Fj(\))26 b Fg(\024)i Fh(f)11
b Fj(\()p Fh(x)p Fj(\))32 b(para)h(to)s(do)g Fh(x)28
b Fg(2)g Fj([)p Fh(a;)17 b(b)p Fj(])26 b Fg(\))2351 2161
y Fe(b)2297 2181 y Fb(Z)2303 2462 y Fe(a)2413 2316 y
Fh(g)t Fj(\()p Fh(x)p Fj(\))p Fh(dx)g Fg(\024)2895 2161
y Fe(b)2840 2181 y Fb(Z)2846 2462 y Fe(a)2956 2316 y
Fh(f)11 b Fj(\()p Fh(x)p Fj(\))p Fh(dx)1466 2559 y Fb(\014)1466
2619 y(\014)1466 2679 y(\014)1466 2739 y(\014)1466 2798
y(\014)1466 2858 y(\014)1554 2608 y Fe(b)1499 2628 y
Fb(Z)1505 2909 y Fe(a)1616 2764 y Fh(f)11 b Fj(\()p Fh(x)p
Fj(\))p Fh(dx)1920 2559 y Fb(\014)1920 2619 y(\014)1920
2679 y(\014)1920 2739 y(\014)1920 2798 y(\014)1920 2858
y(\014)1979 2764 y Fg(\024)2139 2608 y Fe(b)2084 2628
y Fb(Z)2090 2909 y Fe(a)2201 2764 y Fg(j)p Fh(f)g Fj(\()p
Fh(x)p Fj(\))p Fg(j)p Fh(dx)199 3155 y Fj(si)33 b(es)h
Fh(f)43 b Fj(es)34 b(con)m(tin)m(ua)g(con)f(v)-6 b(alores)33
b(en)h Fh(I)-25 b(R)1768 3170 y Ff(+)1868 3155 y Fj(en)m(tonces)2295
3055 y Fe(b)2269 3075 y Fb(R)2271 3246 y Fe(a)2352 3155
y Fh(f)11 b Fj(\()p Fh(x)p Fj(\))p Fh(dx)27 b Fj(=)h(0)f
Fg(,)h Fh(f)11 b Fj(\()p Fh(x)p Fj(\))26 b(=)i(0)33 b(para)g(to)s(do)

```
199 3340 y Fh(x)28 b Fg(2)g Fj([)p Fh(a;)17 b(b)p Fj(])31
b(si)i Fh(f)44 b Fj(y)33 b Fh(g)j Fj(son)e(con)m(tin)m(uas)g(en)m
(tonces)984 3534 y Fb(\014)984 3594 y(\014)984 3653 y(\014)984
3713 y(\014)984 3773 y(\014)984 3833 y(\014)1072 3583
y Fe(b)1017 3603 y Fb(Z)1023 3884 y Fe(a)1134 3738 y
Fh(f)11 b Fj(\()p Fh(x)p Fj(\))p Fh(g)t Fj(\()p Fh(x)p
Fj(\))p Fh(dx)1625 3534 y Fb(\014)1625 3594 y(\014)1625
3653 y(\014)1625 3713 y(\014)1625 3773 y(\014)1625 3833
y(\014)1683 3738 y Fg(\024)1788 3538 y Fb(2)1788 3717
y(4)1909 3583 y Fe(b)1854 3603 y Fb(Z)1860 3884 y Fe(a)1954
3738 y Fj(\()p Fh(f)g Fj(\()p Fh(x)p Fj(\)\))2227 3697
y Ff(2)2270 3738 y Fh(dx)2450 3583 y Fe(b)2395 3603 y
Fb(Z)2401 3884 y Fe(a)2495 3738 y Fj(\()p Fh(g)t Fj(\()p
Fh(x)p Fj(\)\))2760 3697 y Ff(2)2803 3738 y Fh(dx)2912
3538 y Fb(3)2912 3717 y(5)2990 3522 y Fa(1)p 2990 3533
34 4 v 2990 3573 a(2)58 4093 y Fj(v\))49 b(T)-8 b(eorema)32
b(fundamen)m(tal)i(del)f(c\023)-50 b(alculo.)30 4213
y(vi\))49 b(F\023)-50 b(orm)m(ula)37 b(de)h(la)f(mediana:)52
b(Si)38 b Fh(f)45 b Fj(:)35 b([)p Fh(a;)17 b(b)p Fj(])33
b Fg(!)i Fh(I)-25 b(R)37 b Fj(es)h(con)m(tin)m(ua,)h(en)m(tonces)h
(para)d(to)s(da)g(funci\023)-50 b(on)199 4332 y(con)m(tin)m(ua)43
b Fh(\036)e Fj(:)g([)p Fh(a;)17 b(b)p Fj(])40 b Fg(!)h
Fh(I)-25 b(R)1254 4347 y Ff(+)1361 4332 y Fj(\(o)41 b
Fh(I)-25 b(R)1586 4347 y Fd(\000)1653 4332 y Fj(\),)43
b(existe)f(una)g(constan)m(te)g Fh(\026)p Fj(,)h(con)82
b(min)3030 4401 y Fe(x)p Fd(2)p Ff([)p Fe(a;b)p Ff(])3292
4332 y Fh(f)11 b Fj(\()p Fh(x)p Fj(\))41 b Fg(\024)h
Fh(\026)f Fg(\024)229 4597 y Fj(max)199 4666 y Fe(x)p
Fd(2)p Ff([)p Fe(a;b)p Ff(])462 4597 y Fh(f)11 b Fj(\()p
Fh(x)p Fj(\),)43 b(tal)e(que)1106 4497 y Fe(b)1081 4517
y Fb(R)1083 4687 y Fe(a)1164 4597 y Fh(f)11 b Fj(\()p
Fh(x)p Fj(\))p Fh(g)t Fj(\()p Fh(x)p Fj(\))p Fh(dx)40
b Fj(=)j Fh(\026)1917 4497 y Fe(b)1892 4517 y Fb(R)1894
4687 y Fe(a)1975 4597 y Fh(\036)p Fj(\()p Fh(x)p Fj(\))p
Fh(dx)p Fj(.)71 b(Escribir)42 b(la)g(igualdad)g(para)g(el)g(caso)199
4782 y(particular)33 b(en)h(que)f Fh(\036)p Fj(\()p Fh(x)p
Fj(0)28 b(=)g(1)33 b(para)g(to)s(do)g Fh(x)28 b Fg(2)g
Fj([)p Fh(a;)17 b(b)p Fj(].)3 4902 y(vii\))48 b(Cam)m(bio)32
b(de)i(v)-6 b(ariable.)-25 5021 y(viii\))48 b(In)m(tegraci\023)-50
b(on)34 b(p)s(or)f(partes.)30 5141 y(ix\))49 b(In)m(tegraci\023)-50
b(on)34 b(de)g(fracciones)g(racionales.)1888 5380 y(7)p
eop
%%Page: 8 8
8 7 bop 58 100 a Fj(x\))49 b(Aplicaciones:)40 b(C\023)-50
b(alculo)23 b(de)h(\023)-50 b(areas,)25 b(c\023)-50 b(alculo)24
b(del)f(largo)g(de)h(una)g(curv)-6 b(a,)26 b(c\023)-50
b(alculo)23 b(del)h(v)m(olumen)f(de)199 219 y(un)37 b(s\023)-50
b(olido)36 b(de)g(rev)m(oluci\023)-50 b(on,)37 b(c\023)-50
b(alculo)36 b(del)g(v)-6 b(alor)36 b(medio)f(p)s(onderado)i(de)f(una)h
(funci\023)-50 b(on,)38 b(c\023)-50 b(alculo)199 339
y(de)46 b(la)f(masa)g(de)h(una)g(v)-6 b(arilla)44 b(no)h(homog)m(\023)
-47 b(enea,)48 b(c\023)-50 b(alculo)45 b(del)h(cen)m(tro)g(de)g(gra)m
(v)m(edad)g(de)g(una)199 458 y(v)-6 b(arilla)33 b(no)i(homog)m(\023)-47
b(enea,)34 b(c\023)-50 b(alculo)34 b(del)h(momen)m(to)d(de)j(inercia)g
(de)g(una)g(v)-6 b(arilla)33 b(no)h(homog)m(\023)-47
b(enea)199 578 y(con)34 b(resp)s(ecto)g(a)f(un)h(eje,)g(c\023)-50 b
(alculo)33 b(de)h(la)e(presi\023)-50 b(on)34 b(hidrost\023)-50 b(o)
b(atica.)30 697 y(xi\))49 b(In)m(tegral)33 b(de)h(una)g(funci\023)-50 b
(on)34 b(sobre)g(un)g(in)m(terv)-6 b(alo)33 b(no)g(acotado.)3
817 y(xii\))48 b(In)m(tegral)33 b(de)h(una)g(funci\023)-50 b(on)
b(on)34 b(no)g(acotada.)-25 936 y(xiii\))48 b(In)m(tegraci\023)-50 b(on)
b(on)34 b(n)m(um)m(\023)-47 b(erica.)-22 1056 y(xiv\))48
b(Sucesiones)35 b(de)f(Dirac)f(y)g(apro)m(ximaci\023)-50 b(on)
b(on)32 b(uniforme)h(con)h(con)m(v)m(oluci\023)-50 b(on.)6
```

1176 y(xv\))48 b(Segunda)35 b(demostraci\023)-50 b(on)32
b(del)i(T)-8 b(eorema)32 b(de)i(W)-8 b(eirstrass)34 b(median)m(te)f(la)
f(sucesi\023)-50 b(on)35 b(de)f(Dirac)199 1454 y Fh(d)251
1469 y Fe(k)300 1454 y Fj(\()p Fh(x)p Fj(\))27 b(=)579
1386 y(\(1)22 b Fg(\000)h Fh(x)847 1350 y Ff(2)891 1386
y Fj(\))930 1350 y Fe(k)p 579 1431 400 4 v 733 1522 a
Fh(c)776 1537 y Fe(k)1024 1454 y Fj(si)33 b Fh(x)28 b
Fg(2)g Fj([)p Fg(\000)p Fj(1)p Fh(;)17 b Fj(1])32 b(y)h
Fh(d)1751 1469 y Fe(k)1800 1454 y Fj(\()p Fh(x)p Fj(\))27
b(=)h(0)33 b(si)g Fh(x)39 b(=)-61 b Fg(2)28 b Fj([)p
Fg(\000)p Fj(1)p Fh(;)17 b Fj(1])p Fh(;)48 b Fj(con)34
b Fh(c)3009 1469 y Fe(k)3086 1454 y Fj(=)3244 1298 y
Ff(1)3192 1318 y Fb(Z)3169 1601 y Fd(\000)p Ff(1)3293
1454 y Fj(\(1)20 b Fg(\000)h Fh(x)3557 1413 y Ff(2)3601
1454 y Fj(\))3640 1413 y Fe(k)3689 1454 y Fh(dx:)-11
1818 y Fj(11.-)49 b Fi(El)39 b(Espacio)f(V)-10 b(ectorial)37
b(Normado)h Fh(I)-25 b(R)1849 1775 y Fe(n)1903 1818 y
Fi(.)1491 b Fj(\(6,0)33 b(hrs.\))83 2019 y(i\))49 b(Normas)32
b(en)i Fh(I)-25 b(R)796 1975 y Fe(n)850 2019 y Fj(.)44
b(Equiv)-6 b(alencia)33 b(de)g(las)g(tres)h(normas)e(usuales.)55
2138 y(ii\))49 b(Bola)32 b(abierta)h(y)g(b)s(ola)g(cerrada.)28
2258 y(iii\))48 b(Sucesiones)42 b(en)f Fh(I)-25 b(R)929
2214 y Fe(n)983 2258 y Fj(.)64 b(Op)s(eraciones)41 b(con)g(sucesiones.)
66 b(Con)m(v)m(ergencia)40 b(y)g(pun)m(to)h(de)f(acum)m(u-)199
2377 y(laci\023)-50 b(on)33 b(de)h(una)g(sucesi\023)-50
b(on.)30 2497 y(iv\))49 b(Una)43 b(sucesi\023)-50 b(on)45
b(\()6 b(\026)-56 b Fh(x)917 2512 y Fe(k)966 2497 y Fj(\))43
b(en)h Fh(I)-25 b(R)1285 2453 y Fe(n)1383 2497 y Fj(es)44
b(con)m(v)m(ergen)m(te)g(a)g(un)g(pun)m(to)37 b Fh(~)-43
b(a)43 b Fj(si)g(y)g(solo)f(si)i(las)f(sucesiones)199
2616 y(parciales)34 b(\(\()p Fh(x)745 2631 y Ff(1)789
2616 y Fj(\))828 2631 y Fe(k)877 2616 y Fj(\))p Fh(;)17
b Fj(\(\(()p Fh(x)1096 2631 y Ff(2)1139 2616 y Fj(\))1178
2631 y Fe(k)1226 2616 y Fj(\))p Fh(;)g(:::;)g Fj(\(\(\()p
Fh(x)1574 2631 y Fe(n)1625 2616 y Fj(\))1664 2631 y Fe(k)1713
2616 y Fj(\))33 b(con)m(v)m(ergen)i(a)e Fh(a)2384 2631
y Fe(a)2431 2616 y Fh(;)17 b(a)2529 2631 y Ff(2)2573
2616 y Fh(;)g(:::;)g(a)2800 2631 y Fe(n)2885 2616 y Fj(resp)s(ectiv)-6
b(amen)m(te.)58 2736 y(v\))49 b(Pun)m(to)28 b(in)m(terior)f(y)f(pun)m
(to)i(adheren)m(te)h(de)f(una)g(parte)f(de)h Fh(I)-25
b(R)2437 2693 y Fe(n)2491 2736 y Fj(.)42 b(Caracterizaci\023)-50
b(on)27 b(de)h(los)f(pun)m(tos)199 2856 y(adheren)m(tes)35
b(median)m(te)e(sucesiones.)30 2975 y(vi\))49 b(In)m(terior)35
b(y)f(adherencia)h(de)g(una)g(parte)f(de)h Fh(I)-25 b(R)1966
2932 y Fe(n)2020 2975 y Fj(.)47 b(Conjun)m(to)36 b(abierto)e(y)g
(conjun)m(to)h(cerrado)g(en)199 3095 y Fh(I)-25 b(R)294
3051 y Fe(n)348 3095 y Fj(.)3 3214 y(vii\))48 b(L)-11
b(\023)-39 b(\020mite)23 b(de)h(la)g(suma)f(de)i(dos)f(sucesiones)i
(con)m(v)m(ergen)m(tes)g(y)d(l)-11 b(\023)-39 b(\020mite)22
b(del)j(pro)s(ducto)f(p)s(or)g(un)g(escalar)199 3334
y(de)34 b(una)g(sucesi\023)-50 b(on)34 b(con)m(v)m(ergen)m(te.)-25
b 3453 y(viii\))48 b(T)-8 b(eorema)36 b(de)i(Bolzano-W)-8
b(eierstrass:)53 b(Si)37 b Fh(C)45 b Fj(es)38 b(una)f(parte)h(cerrada)g
(y)f(acotada)g(en)g Fh(I)-25 b(R)3577 3410 y Fe(n)3669
3453 y Fj(y)37 b(si)199 3573 y(\()o Fh(~)-49 b(x)295
3588 y Fe(k)344 3573 y Fj(\))37 b(es)h(una)g(sucesi\023)-50
b(on)39 b(en)f Fh(C)7 b Fj(,)38 b(en)m(tonces)h(\()o
Fh(~)-49 b(x)1915 3588 y Fe(k)1964 3573 y Fj(\))37 b(tiene)h(al)f
(menos)g(un)h(pun)m(to)g(de)g(acum)m(ulaci\023)-50 b(on)199
3692 y(en)34 b Fh(C)7 b Fj(.)30 3812 y(ix\))49 b(T)-8
b(eorema)43 b(de)h(Cauc)m(h)m(y:)66 b(Una)43 b(condici\023)-50
b(on)44 b(necesaria)h(y)e(su\014cien)m(te)j(para)d(que)h(una)g
(sucesi\023)-50 b(on)199 3931 y(\()o Fh(~)-49 b(x)295 3946
y Fe(k)344 3931 y Fj(\))33 b(en)h Fh(I)-25 b(R)644 3888

```
y Fe(n)731 3931 y Fj(sea)34 b(con)m(v)m(ergen)m(te,)g(es)g(que)f(para)g
(to)s(do)g Fh(\017)28 b(>)g Fj(0)33 b(exista)g(un)h(natural)f
Fh(K)40 b Fj(tal)32 b(que)1290 4084 y Fg(k)o Fh(~)-49
b(x)1397 4099 y Fe(i)1452 4084 y Fg(\000)21 b Fh(~)-49
b(x)1608 4099 y Fe(j)1650 4084 y Fg(k)28 b(\024)g Fh(\017)33
b Fj(para)h(to)s(do)e Fh(i;)17 b(j)33 b Fg(\025)28 b
Fh(K)r(:)0 4317 y Fi(BIBLIOGRAFIA)116 4518 y Fj(-)50
b(APOSTOL,)34 b(T.,)f(C\023)-50 b(alculo,)32 b(V)-8 b(ol.)43
b(I,)33 b(Rev)m(ert)m(\023)-47 b(e,)33 b(\(1965\).)116
4638 y(-)50 b(CAR)-8 b(T)g(AN,)32 b(H.,)g(Calculus)i(Diferencial,)f
(Omega,)g(\(1972\).)116 4757 y(-)50 b(FRIEDMAN,)33 b(A.,)f(Adv)-6
b(anced)35 b(Calculus,)e(Holt-Rinehart)g(and)h(Winston,)f(\(1971\).)116
4877 y(-)50 b(KITCHEN,)33 b(J.,)f(Calculus)i(of)g(One)g(V)-8
b(ariable,)32 b(Addison-W)-8 b(esley)g(,)33 b(\(1968\).)116
4996 y(-)50 b(LANG,)33 b(S.,)g(Analysis)g(I,)f(Addison-W)-8
b(esley)g(,)34 b(\(1968\).)116 5116 y(-)50 b(SPIV)-11
b(AK,)33 b(M.,)g(C\023)-50 b(alculo)33 b(In\014nitesimal,)f(Rev)m(ert)m
(\023)-47 b(e,)33 b(\(1970\).)1888 5380 y(8)p eop
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