

· Effetto Joule	
 ⟨<!-- ⟨ --> P R ⟩<!-- ⟩ --> = V 0 2 R {\displaystyle \langle P_{R}\rangle ={\frac {V_{0}}{2R}}} 	(180)
· Potenza media totale	
 ⟨<!-- ⟨ --> P ⟩<!-- ⟩ --> = V 0 I 0 2 cos ⁡<!-- ⁡ --> (ϕ<!-- ϕ -->) {\displaystyle \langle P\rangle ={\frac {V_{0}I_{0}}{2}}\cos(\phi)} 	(181)
· V e I efficace	
 V e f f = √<!-- √ --> 2 2 V 0 I e f f = √<!-- √ --> 2 2 I 0 {\displaystyle V_{eff}={\frac {\sqrt {2}}{2}}V_{0}\quad I_{eff}={\frac {\sqrt {2}}{2}}I_{0}} 	(182)

■ CAMPO EM e OTTICA

· Campi in un’onda EM (Nel vuoto <i>v</i> = <i>c</i>)	
 E (x , t) = E 0 cos ⁡<!-- ⁡ --> (k x −<!-- − --> ω<!-- ω --> t) {\displaystyle E(x,t)=E_{0}\cos(kx-\omega t)} 	(183)
 B (x , t) = E 0 v cos ⁡<!-- ⁡ --> (k x −<!-- − --> ω<!-- ω --> t) {\displaystyle B(x,t)={\frac {E_{0}}{v}}\cos(kx-\omega t)} 	(184)
 ω<!-- ω --> = k v k = 2 π<!-- π --> λ<!-- λ --> λ<!-- λ --> = v ν<!-- ν --> {\displaystyle \omega =kv\quad k={\frac {2\pi }{\lambda }}\quad \lambda ={\frac {v}{\nu }}} 	
· Vettore di Poynting	
 S = 1 μ<!-- μ --> 0 E ×<!-- × --> B {\displaystyle {\bold {S}}={\frac {1}{\mu _{0}}}{\bold {E}}\times {\bold {B}}} 	(185)
· Intensità media onda	
 I = ⟨<!-- ⟨ --> S ⟩<!-- ⟩ --> = ⟨<!-- ⟨ --> E 2 ε<!-- ε --> v ⟩<!-- ⟩ --> {\displaystyle I=\langle S\rangle =\langle E^{2}\varepsilon v\rangle } 	(186)
· Potenza	
 P = I Σ<!-- Σ --> {\displaystyle P=I\Sigma } 	(187)
L’intensità varia in base alla scelta di Σ	
· Equazioni di continuità Teorema di Poynting	
 ∇<!-- ∇ --> ⋅<!-- ⋅ --> S + E ⋅<!-- ⋅ --> j →<!-- → --> + ∂<!-- ∂ --> u ∂<!-- ∂ --> t = 0 {\displaystyle \nabla \cdot {\bold {S}}+{\bold {E}}\cdot {\bold {j}}+{\frac {\partial u}{\partial t}}=0} 	(188)
Conservazione della carica	
 ∇<!-- ∇ --> ⋅<!-- ⋅ --> j →<!-- → --> + ∂<!-- ∂ --> ρ<!-- ρ --> ∂<!-- ∂ --> t = 0 {\displaystyle \nabla \cdot {\bold {j}}+{\frac {\partial \rho }{\partial t}}=0} 	(189)
· Densità di en. campo EM	
 u E M = 1 2 (E ⋅<!-- ⋅ --> D + B ⋅<!-- ⋅ --> H) {\displaystyle u_{EM}={\frac {1}{2}}({\bold {E}}\cdot {\bold {D}}+{\bold {B}}\cdot {\bold {H}})} 	(190)
 U E M = ∫<!-- ∫ --> R 3 u E M d τ<!-- τ --> {\displaystyle U_{EM}=\int _{\mathbb {R} ^{3}}u_{EM}\mathrm {d} \tau } 	(191)
· Densità di quantità di moto	
 g = S c 2 {\displaystyle {\bold {g}}={\frac {\bold {S}}{c^{2}}}} 	(192)
· Effetto Doppler	
 ν<!-- ν --> ′ = ν<!-- ν --> v −<!-- − --> v o s s v −<!-- − --> v s o r g {\displaystyle \nu '=\nu {\frac {v-v_{oss}}{v-v_{sorg}}}} 	(193)
· Oscillazione del dipolo	
 I (r , θ<!-- θ -->) = I 0 r 2 sin 2 ⁡<!-- ⁡ --> (θ<!-- θ -->) {\displaystyle I(r,\theta)={\frac {I_{0}}{r^{2}}}\sin ^{2}(\theta)} 	(194)
 P = ∫<!-- ∫ --> ∫<!-- ∫ --> I (r , θ<!-- θ -->) d r d θ<!-- θ --> = 8 3 π<!-- π --> I 0 {\displaystyle P=\int \int I(r,\theta)\mathrm {d} r\mathrm {d} \theta ={\frac {8}{3}}\pi I_{0}} 	(195)
· Velocità dell’onda	
 v 2 = 1 k e ε<!-- ε --> 0 k m μ<!-- μ --> 0 {\displaystyle v^{2}={\frac {1}{k_{e}\varepsilon _{0}k_{m}\mu _{0}}}} 	(196)
 c 2 = 1 ε<!-- ε --> 0 μ<!-- μ --> 0 {\displaystyle c^{2}={\frac {1}{\varepsilon _{0}\mu _{0}}}} 	(197)

■ UNITÀ DI MISURA

 H = W b A = T m 2 = m 2 k g A 2 s 2 {\displaystyle H={\frac {Wb}{A}}=Tm^{2}={\frac {m^{2}kg}{A^{2}s^{2}}}} 	(255)
 Ω<!-- Ω --> = V A = V 2 W = m 2 k g A 2 s 3 {\displaystyle \Omega ={\frac {V}{A}}={\frac {V^{2}}{W}}={\frac {m^{2}kg}{A^{2}s^{3}}}} 	(256)
 T = N A m = k g A s 2 {\displaystyle T={\frac {N}{Am}}={\frac {kg}{As^{2}}}} 	(257)
 V = J C = W A = m 2 k g s 3 A {\displaystyle V={\frac {J}{C}}={\frac {W}{A}}={\frac {m^{2}kg}{s^{3}A}}} 	(258)
 F = C V = C 2 J = A 2 s 4 m 2 k g {\displaystyle F={\frac {C}{V}}={\frac {C^{2}}{J}}={\frac {A^{2}s^{4}}{m^{2}kg}}} 	(259)

■ FISICA 1

· Momento torcente	
 M = r ×<!-- × --> F = I α<!-- α --> {\displaystyle M=\mathbf {r} \times \mathbf {F} =I\alpha } 	(260)

· Indice di rifrazione	
 n = c v = √<!-- √ --> k e k m {\displaystyle n={\frac {c}{v}}={\sqrt {k_{e}k_{m}}}} 	(198)

· Legge di Snell-Cartesio

 n 1 sin ⁡<!-- ⁡ --> θ<!-- θ --> 1 = n 2 sin ⁡<!-- ⁡ --> θ<!-- θ --> 2 {\displaystyle n_{1}\sin \theta _{1}=n_{2}\sin \theta _{2}} 	(199)
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· Coefficienti di Fresnel

Definizione	
 r = E r E i R = P r P i = I r I i {\displaystyle r={\frac {E_{r}}{E_{i}}}\quad R={\frac {P_{r}}{P_{i}}}={\frac {I_{r}}{I_{i}}}} 	(200)

 t = E t E i T = P t P i = I t I i {\displaystyle t={\frac {E_{t}}{E_{i}}}\quad T={\frac {P_{t}}{P_{i}}}={\frac {I_{t}}{I_{i}}}} 	(201)
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Raggio RIFLESSO polarizzato	
 r σ<!-- σ --> = sin ⁡<!-- ⁡ --> (θ<!-- θ --> t −<!-- − --> θ<!-- θ --> i) sin ⁡<!-- ⁡ --> (θ<!-- θ --> t + θ<!-- θ --> i) {\displaystyle r_{\sigma }={\frac {\sin(\theta _{t}-\theta _{i})}{\sin(\theta _{t}+\theta _{i})}}} 	(202)

 r π<!-- π --> = tan ⁡<!-- ⁡ --> (θ<!-- θ --> t −<!-- − --> θ<!-- θ --> i) tan ⁡<!-- ⁡ --> (θ<!-- θ --> t + θ<!-- θ --> i) {\displaystyle r_{\pi }={\frac {\tan(\theta _{t}-\theta _{i})}{\tan(\theta _{t}+\theta _{i})}}} 	(203)
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 R σ<!-- σ --> = r σ<!-- σ --> 2 R π<!-- π --> = r π<!-- π --> 2 {\displaystyle R_{\sigma }=r_{\sigma }^{2}\quad R_{\pi }=r_{\pi }^{2}} 	(204)
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Raggio TRASMESSO polarizzato	
 t σ<!-- σ --> = 2 n i cos ⁡<!-- ⁡ --> θ<!-- θ --> i n i cos ⁡<!-- ⁡ --> θ<!-- θ --> i + n t cos ⁡<!-- ⁡ --> θ<!-- θ --> t {\displaystyle t_{\sigma }={\frac {2n_{i}\cos \theta _{i}}{n_{i}\cos \theta _{i}+n_{t}\cos \theta _{t}}}} 	(205)

 t p i = 2 n i cos ⁡<!-- ⁡ --> θ<!-- θ --> i n i cos ⁡<!-- ⁡ --> θ<!-- θ --> t + n t cos ⁡<!-- ⁡ --> θ<!-- θ --> i {\displaystyle t_{p}i={\frac {2n_{i}\cos \theta _{i}}{n_{i}\cos \theta _{t}+n_{t}\cos \theta _{i}}}} 	(206)
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 T σ<!-- σ --> = 1 −<!-- − --> R σ<!-- σ --> T π<!-- π --> = 1 −<!-- − --> R π<!-- π --> {\displaystyle T_{\sigma }=1-R_{\sigma }\quad T_{\pi }=1-R_{\pi }} 	(207)
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Luce NON polarizzata	
 R = 1 2 (R σ<!-- σ --> + R π<!-- π -->) T = 1 2 (T σ<!-- σ --> + T π<!-- π -->) {\displaystyle R={\frac {1}{2}}(R_{\sigma }+R_{\pi })\quad T={\frac {1}{2}}(T_{\sigma }+T_{\pi })} 	(208)

Incidenza normale (cos θ _i ? cos θ _t = 1)	
 r = n i −<!-- − --> n t n i + n t {\displaystyle r={\frac {n_{i}-n_{t}}{n_{i}+n_{t}}}} 	(209)

 R = (n i −<!-- − --> n t n i + n t) 2 {\displaystyle R=\left({\frac {n_{i}-n_{t}}{n_{i}+n_{t}}}\right)^{2}} 	(210)
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 t = 2 n i n i + n t {\displaystyle t={\frac {2n_{i}}{n_{i}+n_{t}}}} 	(211)
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 T = 4 n i n t (n i + n t) 2 {\displaystyle T={\frac {4n_{i}n_{t}}{(n_{i}+n_{t})^{2}}}} 	(212)
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Angolo di Brewster (il raggio riflesso non ha polar. parallela)	
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 θ<!-- θ --> i + θ<!-- θ --> t = π<!-- π --> 2 →<!-- → --> θ<!-- θ --> B = θ<!-- θ --> i = arctan ⁡<!-- ⁡ --> n t n i {\displaystyle \theta _{i}+\theta _{t}={\frac {\pi }{2}}\rightarrow \theta _{B}=\theta _{i}=\arctan {\frac {n_{t}}{n_{i}}}} 	(213)
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 R = 1 2 cos 2 ⁡<!-- ⁡ --> (2 θ<!-- θ --> i) {\displaystyle R={\frac {1}{2}}\cos ^{2}(2\theta _{i})} 	(214)
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 T = 1 −<!-- − --> R {\displaystyle T=1-R} 	(215)
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· Pressione di radiazione

Superficie ASSORBENTE	
 p = I i v {\displaystyle p={\frac {I_{i}}{v}}} 	(216)

Superficie RIFLETTENTE	
 p = I i + I t + I r v {\displaystyle p={\frac {I_{i}+I_{t}+I_{r}}{v}}} 	(217)

· Rapporto di polarizzazione

 β<!-- β --> R = P R σ<!-- σ --> −<!-- − --> P R π<!-- π --> P R σ<!-- σ --> + P R π<!-- π --> {\displaystyle \beta _{R}={\frac {P_{R}^{\sigma }-P_{R}^{\pi }}{P_{R}^{\sigma }+P_{R}^{\pi }}}}} 	(218)
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 β<!-- β --> T = P T σ<!-- σ --> −<!-- − --> P T π<!-- π --> P T σ<!-- σ --> + P T π<!-- π --> {\displaystyle \beta _{T}={\frac {P_{T}^{\sigma }-P_{T}^{\pi }}{P_{T}^{\sigma }+P_{T}^{\pi }}}}} 	(219)
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■ INTERFERENZA e DIFFRAZIO-NE

· Lavoro	
 F = ∇<!-- ∇ --> W = −<!-- − --> ∇<!-- ∇ --> U {\displaystyle F=\nabla W=-\nabla U} 	(261)

· Moto circolare unif. accelerato

 v = ω<!-- ω --> r {\displaystyle v=\omega r} 	(262)
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 a = v 2 r = ω<!-- ω --> 2 r {\displaystyle a={\frac {v^{2}}{r}}=\omega ^{2}r} 	(263)
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 θ<!-- θ --> (t) = θ<!-- θ --> (0) + ω<!-- ω --> (0) t + 1 2 α<!-- α --> t 2 {\displaystyle \theta (t)=\theta (0)+\omega (0)t+{\frac {1}{2}}\alpha t^{2}} 	(264)
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· Moto armonico

Equazione differenziale	
 x ″<!-- ′′ --> + ω<!-- ω --> 2 x = 0 {\displaystyle x''+\omega ^{2}x=0} 	(265)

Soluzione	
 x (t) = A sin ⁡<!-- ⁡ --> (ω<!-- ω --> t + ϕ<!-- ϕ -->) {\displaystyle x(t)=A\sin(\omega t+\varphi)} 	(266)

· Interferenza generica Onda risultante	
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 f (r , t) = A e i (k r 1 −<!-- − --> ω<!-- ω --> t + α<!-- α -->) {\displaystyle f(\mathbf {r} ,t)=Ae^{i(kr_{1}-\omega t+\alpha)}} 	(220)
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Ampiezza	
 A = √<!-- √ --> A 1 2 + A 2 2 + 2 A 1 A 2 cos ⁡<!-- ⁡ --> δ<!-- δ --> {\displaystyle A={\sqrt {A_{1}^{2}+A_{2}^{2}+2A_{1}A_{2}\cos \delta }}} 	(221)

Diff. cammino ottico	
 δ<!-- δ --> = α<!-- α --> 2 −<!-- − --> α<!-- α --> 1 = (Φ<!-- Φ --> 2 −<!-- − --> Φ<!-- Φ --> 1 + k (r 2 −<!-- − --> r 1) {\displaystyle \delta =\alpha _{2}-\alpha _{1}=(\Phi _{2}-\Phi _{1}+k(r_{2}-r_{1})} 	(222)

Intensità	
 I = I 1 + I 2 + 2 √<!-- √ --> I 1 I 2 cos ⁡<!-- ⁡ --> δ<!-- δ --> {\displaystyle I=I_{1}+I_{2}+2{\sqrt {I_{1}I_{2}}}\cos \delta } 	(223)

Fase risultante α	
 tan ⁡<!-- ⁡ --> α<!-- α --> = A 1 sin ⁡<!-- ⁡ --> α<!-- α --> 1 + A 2 sin ⁡<!-- ⁡ --> α<!-- α --> 2 A 1 cos ⁡<!-- ⁡ --> α<!-- α --> 1 + A 2 cos ⁡<!-- ⁡ --> α<!-- α --> 2 {\displaystyle \tan \alpha ={\frac {A_{1}\sin \alpha _{1}+A_{2}\sin \alpha _{2}}{A_{1}\cos \alpha _{1}+A_{2}\cos \alpha _{2}}}} 	(224)

Massimi	
 δ<!-- δ --> = 2 n π<!-- π --> {\displaystyle \delta =2n\pi } 	(225)

Minimi	
 δ<!-- δ --> = (2 n + 1) π<!-- π --> {\displaystyle \delta =(2n+1)\pi } 	(226)

· Condizione di Fraunhofer

 θ<!-- θ --> = Δ<!-- Δ --> y L {\displaystyle \theta ={\frac {\Delta y}{L}}} 	(227)
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L grande tale che tan θ ≈ θ	
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· Interferenza in fase

Diff. cammino ottico	
 δ<!-- δ --> = k (r 2 −<!-- − --> r 1) = 2 π<!-- π --> λ<!-- λ --> d sin ⁡<!-- ⁡ --> θ<!-- θ --> {\displaystyle \delta =k(r_{2}-r_{1})={\frac {2\pi }{\lambda }}d\sin \theta } 	(228)

Costruttiva	
 r 2 −<!-- − --> r 1 = n λ<!-- λ --> →<!-- → --> sin ⁡<!-- ⁡ --> θ<!-- θ --> = n λ<!-- λ --> d n ∈<!-- ∈ --> Z<!-- Z --> {\displaystyle r_{2}-r_{1}=n\lambda \rightarrow \sin \theta =n{\frac {\lambda }{d}}\quad n\in \mathbb {Z} } 	(229)

Distruttiva	
 r 2 −<!-- − --> r 1 = 2 n + 1 2 λ<!-- λ --> →<!-- → --> sin ⁡<!-- ⁡ --> θ<!-- θ --> = 2 n + 1 2 λ<!-- λ --> d n ∈<!-- ∈ --> Z<!-- Z --> {\displaystyle r_{2}-r_{1}={\frac {2n+1}{2}}\lambda \rightarrow \sin \theta ={\frac {2n+1}{2}}{\frac {\lambda }{d}}\quad n\in \mathbb {Z} } 	(230)

· Interf. riflessione su lastra sottile

(<i>n</i> indice rifr., <i>t</i> spessore lastra) Diff. cammino ottico	
 δ<!-- δ --> = 2 π<!-- π --> 2 n t λ<!-- λ --> cos ⁡<!-- ⁡ --> θ<!-- θ --> t {\displaystyle \delta ={\frac {2\pi }{\lambda }}{\frac {2nt}{\cos \theta _{t}}}} 	(231)

Massimi <i>m</i> ∈ ℕ	
 t = 2 m + 1 4 n λ<!-- λ --> cos ⁡<!-- ⁡ --> θ<!-- θ --> t {\displaystyle t={\frac {2m+1}{4n}}\lambda \cos \theta _{t}} 	(232)

Minimi <i>m</i> ∈ ℕ	
 t = m 2 n λ<!-- λ --> cos ⁡<!-- ⁡ --> θ<!-- θ --> t {\displaystyle t={\frac {m}{2n}}\lambda \cos \theta _{t}} 	(233)

· Interferenza N fenditure

Diff. cammino ottico	
 δ<!-- δ --> = 2 π<!-- π --> λ<!-- λ --> d sin ⁡<!-- ⁡ --> θ<!-- θ --> {\displaystyle \delta ={\frac {2\pi }{\lambda }}d\sin \theta } 	(234)

Intensità	
 I (θ<!-- θ -->) = I 0 (sin ⁡<!-- ⁡ --> (N δ<!-- δ --> 2) sin ⁡<!-- ⁡ --> δ<!-- δ --> 2) 2 {\displaystyle I(\theta)=I_{0}\left({\frac {\sin(N{\frac {\delta }{2}})}{\sin {\frac {\delta }{2}}}}\right)^{2}} 	(235)

Massimi principali <i>m</i> ∈ ℤ	
 δ<!-- δ --> = 2 m π<!-- π --> →<!-- → --> sin ⁡<!-- ⁡ --> θ<!-- θ --> = m λ<!-- λ --> d {\displaystyle \delta =2m\pi \rightarrow \sin \theta ={\frac {m\lambda }{d}}} 	(236)

 I M A X = N 2 I 0 {\displaystyle I_{MAX}=N^{2}I_{0}} 	(237)
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· Attrito viscoso

Equazione differenziale	
 v ′ + v τ<!-- τ --> = K {\displaystyle v'+{\frac {v}{\tau }}=K} 	(267)

Soluzione	
 v (t) = k τ<!-- τ --> (1 −<!-- − --> e −<!-- − --> t τ<!-- τ -->) {\displaystyle v(t)=k\tau (1-e^{-{\tfrac {t}{\tau }}})} 	(268)

■ ANALISI MATEMATICA

· Integrali ricorrenti

 ∫<!-- ∫ --> 1 x 2 + r 2 d x = 1 r arctan ⁡<!-- ⁡ --> x r {\displaystyle \int {\frac {1}{x^{2}+r^{2}}}\mathrm {d} x={\frac {1}{r}}\arctan {\frac {x}{r}}} 	(269)
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 ∫<!-- ∫ --> 1 √<!-- √ --> x 2 + r 2 d x = ln ⁡<!-- ⁡ --> √<!-- √ --> x 2 + r 2 + x {\displaystyle \int {\frac {1}{\sqrt {x^{2}+r^{2}}}}\mathrm {d} x=\ln {\sqrt {x^{2}+r^{2}}}+x} 	(270)
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Massimi secondari <i>m</i> ∈ ℤ − { <i>kN</i> , <i>kN</i> − 1 con <i>k</i> ∈ ℤ}	
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 δ<!-- δ --> = 2 m + 1 2 N π<!-- π --> →<!-- → --> sin ⁡<!-- ⁡ --> θ<!-- θ --> = 2 m + 1 2 N λ<!-- λ --> d {\displaystyle \delta ={\frac {2m+1}{2N}}\pi \rightarrow \sin \theta ={\frac {2m+1}{2N}}{\frac {\lambda }{d}}} 	(238)
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 I S E C = I 0 (sin ⁡<!-- ⁡ --> π<!-- π --> d sin ⁡<!-- ⁡ --> θ<!-- θ --> λ) 2 {\displaystyle I_{SEC}={\frac {I_{0}}{\left(\sin {\frac {\pi d\sin \theta }{\lambda }}\right)^{2}}} 	(239)
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Minimi <i>m</i> ∈ ℤ − { <i>kN</i> }	
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 δ<!-- δ --> = 2 m N π<!-- π --> →<!-- → --> sin ⁡<!-- ⁡ --> θ<!-- θ --> = m λ<!-- λ --> N d {\displaystyle \delta ={\frac {2m}{N}}\pi \rightarrow \sin \theta ={\frac {m\lambda }{Nd}}} 	(240)
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 I M I N = 0 {\displaystyle I_{MIN}=0} 	(241)
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Separazione angolare (distanza angolare tra min. e max. adiacente)	
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· Differenziale di primo ordine

Forma generale

$y'(t)+a(t)y(t)=b(t)$

(276)

Soluzione

$y(t)=e^{-A(t)(c+\int b(t)e^{A(t)}dt)}$

(277)

· Differenziale di secondo ordine omo-geneo

Forma generale

$y''+ay'+by=0$

$a,b\in\mathbb{R}$

(278)

$\lambda_{1,2}\in\mathbb{C}$ sono le soluzioni dell'equazione associata

Soluzioni

Se $\Delta > 0$

$y(t)=c_1e^{\lambda_1t}+c_2e^{\lambda_2t}$

(279)

Se $\Delta = 0$

$y(t)=c_1e^{\lambda_1t}+tc_2e^{\lambda_2t}$

(280)

Se $\Delta < 0$

$y(t)=c_1e^{\alpha t}\cos(\beta t)+c_2e^{\alpha t}\sin(\beta t)$

(281)

con $\alpha = Re(\lambda)$ e $\beta = Im(\lambda)$

· Identità vettoriali

$\nabla\cdot(\nabla\times\mathbf{A})=0$

(282)

$\nabla\times(\nabla f)=0$

(283)

$\nabla\cdot(f\mathbf{A})=f\nabla\cdot\mathbf{A}+\mathbf{A}\cdot\nabla f$

(284)

$\nabla(\mathbf{A}\cdot\mathbf{B})=\mathbf{B}\cdot(\nabla\times\mathbf{A})-\mathbf{A}\cdot(\nabla\times\mathbf{B})$

(285)

$\nabla\times(\nabla\times\mathbf{A})=\nabla(\nabla\cdot\mathbf{A})-\nabla^2\mathbf{A}$

(286)

$\mathbf{A}\times(\mathbf{B}\times\mathbf{C})=\mathbf{B}(\mathbf{A}\cdot\mathbf{C})-\mathbf{C}(\mathbf{A}\cdot\mathbf{B})$

(287)

· Identità geometriche

$\sin(\alpha\pm\beta)=\sin\alpha\cos\beta\pm\cos\alpha\sin\beta$

(288)

$\cos(\alpha\pm\beta)=\cos\alpha\cos\beta\mp\sin\alpha\sin\beta$

(289)

$\cos\frac{\alpha}{2}=\pm\sqrt{\frac{1+\cos\alpha}{2}}$

(290)

$\sin\frac{\alpha}{2}=\pm\sqrt{\frac{1-\cos\alpha}{2}}$

(291)

$\tan\frac{\alpha}{2}=\frac{1-\cos\alpha}{\sin\alpha}=\frac{\sin\alpha}{1+\cos\alpha}$

(292)

	Cartesiane	Sferiche	Cilindriche
Gradiente ($\nabla f =$)	$\frac{\partial f}{\partial x}\mathbf{x}+\frac{\partial f}{\partial y}\mathbf{y}+\frac{\partial f}{\partial z}\mathbf{z}$	$\frac{\partial f}{\partial r}\mathbf{r}+\frac{1}{r}\frac{\partial f}{\partial \theta}\boldsymbol{\theta}+\frac{1}{r\sin\theta}\frac{\partial f}{\partial \phi}\boldsymbol{\phi}$	$\frac{\partial f}{\partial r}\mathbf{r}+\frac{1}{r}\frac{\partial f}{\partial \theta}\boldsymbol{\theta}+\frac{\partial f}{\partial z}\mathbf{z}$
Divergenza ($\nabla\cdot\mathbf{F} =$)	$\frac{\partial F_x}{\partial x}+\frac{\partial F_y}{\partial y}+\frac{\partial F_z}{\partial z}$	$\frac{1}{r^2}\frac{\partial r^2F_r}{\partial r}+\frac{1}{r\sin\theta}\frac{\partial F_\theta\sin\theta}{\partial \theta}+\frac{1}{r\sin\theta}\frac{\partial F_\phi}{\partial \phi}$	$\frac{1}{r}\frac{\partial(rF_r)}{\partial r}+\frac{1}{r}\frac{\partial F_\theta}{\partial \theta}+\frac{\partial F_z}{\partial z}$
Rotore ($\nabla\times\mathbf{F} =$)	$\left(\begin{array}{cc}\frac{\partial F_z}{\partial y}-\frac{\partial F_y}{\partial z}\\\frac{\partial F_x}{\partial z}-\frac{\partial F_z}{\partial x}\\\frac{\partial F_y}{\partial x}-\frac{\partial F_x}{\partial y}\end{array}\right)$	$\left(\begin{array}{c}\frac{1}{r\sin\theta}\left(\frac{\partial F_\phi\sin\theta}{\partial \theta}-\frac{\partial F_\theta}{\partial \phi}\right)\\\frac{1}{r}\left(\frac{1}{\sin\theta}\frac{\partial F_r}{\partial \phi}-\frac{\partial(rF_\phi)}{\partial r}\right)\\\frac{1}{r}\left(\frac{\partial(rF_\theta)}{\partial r}-\frac{\partial F_r}{\partial \theta}\right)\end{array}\right)$	$\left(\begin{array}{c}\left(\frac{1}{r}\frac{\partial F_z}{\partial \phi}-\frac{\partial F_\phi}{\partial z}\right)\\\left(\frac{\partial F_r}{\partial z}-\frac{\partial F_z}{\partial r}\right)\\\frac{1}{r}\left(\frac{\partial(rF_\phi)}{\partial r}-\frac{\partial F_r}{\partial \phi}\right)\end{array}\right)$
Il laplaciano di un campo scalare Φ , in qualunque coordinata, è $\nabla\cdot\nabla\Phi$			