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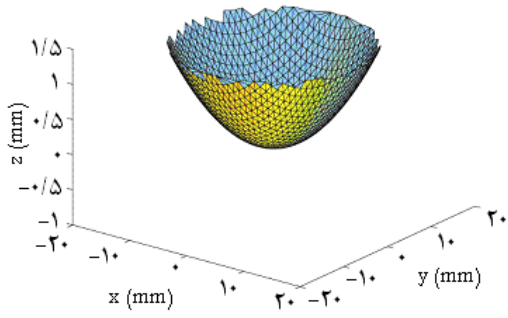
[ ]

[ ]

[ ] (O'Neil)

$$p(r) = \frac{\rho c}{\lambda} \int_s^u \frac{e^{-(\alpha+ik)r}}{r} ds \quad (1)$$

$\rho$        $p$   
 $c$        $\lambda$   
 $u$        $k$        $\alpha$



$N \times N$

$$p(r) = \frac{\rho c}{\lambda} \sum_{j=1}^N \int_s u \frac{e^{-(\alpha+ik)r_j}}{r_j} ds_j \quad ( )$$

[ ]

$$Q = \frac{\alpha}{\rho c} |p(r)|^2 \quad ( )$$

$\alpha$

$$z = \rho c$$

[ ]

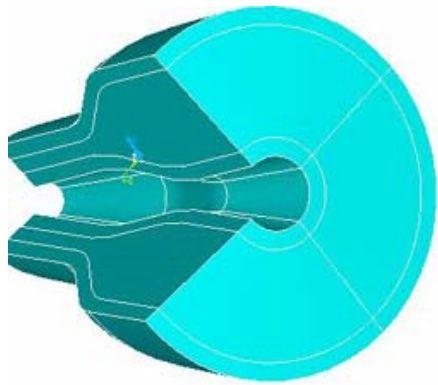
$c$ (m/s)	$\rho$ (kg/m <sup>3</sup> )	$\alpha$ (Nep/m)

<sup>1</sup>Extreme Near Field

<sup>2</sup>Mid Field (Transition region)

<sup>3</sup>Far field

<sup>4</sup>Side Loop and Main Loop



[ 1 ]

$Q$ .

$k$

$$\rho_t c_t \left( \frac{\partial T}{\partial t} + W_b \frac{\partial T}{\partial z} \right) = \nabla \cdot (k \nabla T) - W_b c_b (T - T_a) + Q$$

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$$\rho_t c_t \frac{\partial T}{\partial t} = \nabla \cdot (k \nabla T) - W_b c_b (T - T_a) + Q \quad ( )$$

)

$W_b$

$T$

(

$T_a$ .

$kgm^{-3}$	$(\rho_b)$
$kgm^{-3}$	$(\rho_t)$
$kgm^{-3}$	$(C_b)$
$( ) kgm^{-3}s^{-1}$	$(W_b) ( )$
$^{\circ}C$	$(T_b)$

[ ]

$T_{\infty} h$

" "

$$T(x, y, z) = T_0, \quad t = 0, \quad ( )$$

$$\left. \frac{\partial T}{\partial r} \right|_{s_f} = 0, \quad t > 0. \quad ( )$$

( )

$$T(x, y, z) = \sum_{e=1}^r N_e(x, y, z) T_e(t) \quad ( )$$

[ ]

$$[C]\{\dot{T}\} + [K]\{T\} = \{F\} \quad ( )$$

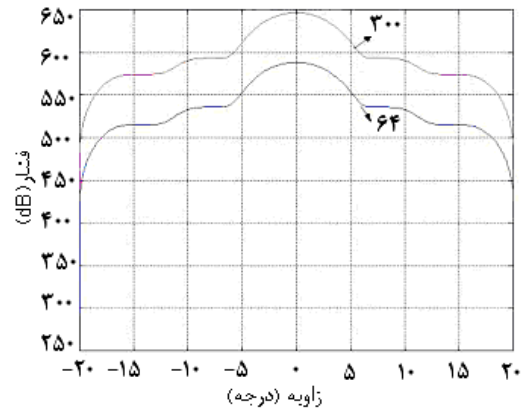
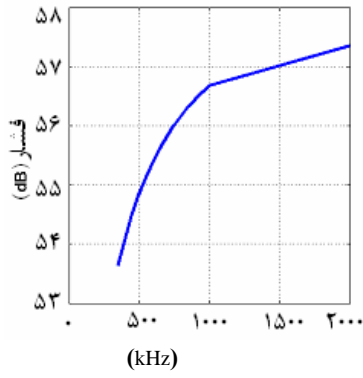
$$[C]^e = \int \rho c \{N\} \langle N \rangle dv$$

$$[K]^e = \int_{V_e} [B]^T [k] [B] dv + \iint_{S_e} h \{N\} \langle N \rangle ds + \iint_{S_e} W_b \{N\} \langle N \rangle ds$$

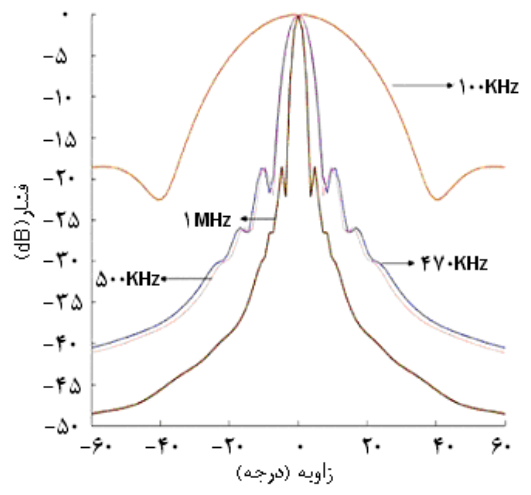
$$\{F\}^e = \int_{S_e} h T_{\infty} \{N\} ds + \int_{V_e} Q \{N\} dv +$$

$$\int_{S_e} [k] [B] \{N\} ds + \int_{S_e} W_b T_a \{N\} ds$$

$$[B] = \begin{bmatrix} \partial_x N_1 & K & \partial_x N_r \\ \partial_y N_1 & K & \partial_y N_r \\ \partial_z N_1 & K & \partial_z N_r \end{bmatrix} \quad ( )$$



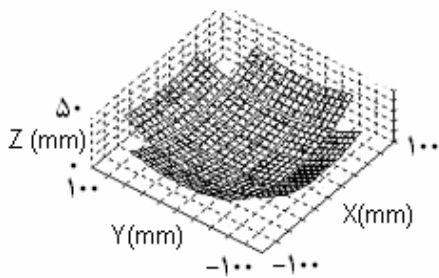
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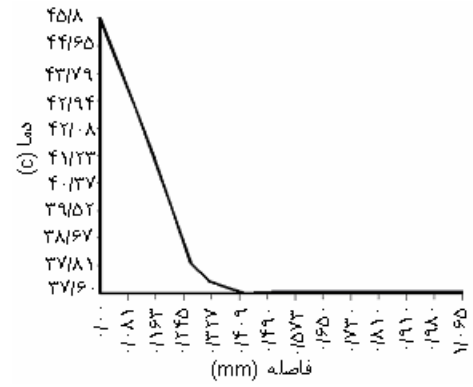
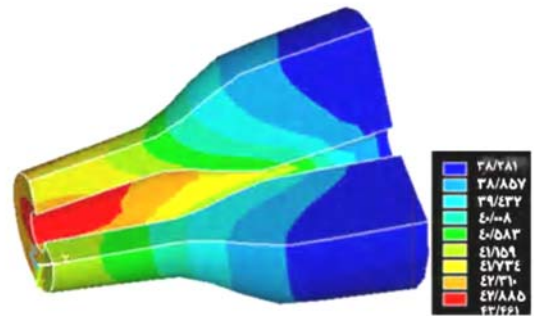
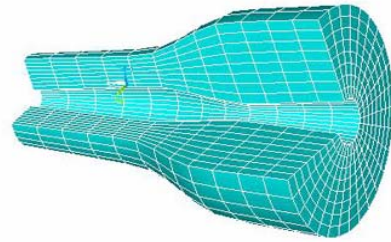


kHz  
kHz  
kHz

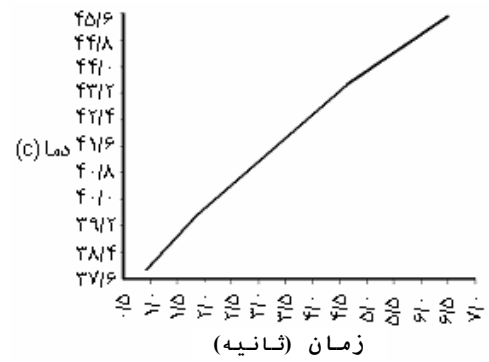
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kHz





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- [9] Haemmerich DG, PhD Thesis; finite element modeling of hepatic radio frequency ablation; University of Wisconsin-Madison 2000.
- [10] Fatemi F, Greenleaf JF; Probing the dynamics of tissue at low frequencies with the radiation force of ultrasound; *Phys Med Biol* 2000; 45: 1449.
- [11] Lu B, Yang R, Lin W, Cheng K, Wang C, Kuo T; Theoretical study of convergent ultrasound hyperthermia for treating bone tumors; *Medical Engineering & Physics* 2000; 22: 253.
- [12] Behrens S, Spengos K, Daffertshofer M, Schroeck H, Dimplfle CE, Hennerici M; Potential use of therapeutic ultrasound in ischemic stroke treatment; *Ultrasound in Med & Biol* 2001; 27: 1683.
- [13] Speed CA; Therapeutic ultrasound in soft tissue lesions; *Rheumatology* 2001; 40: 1331.
- [14] Kluiwstra J, McGough D, Hamilton M, Donnell O, Cain A; Therapeutic Ultrasound Phased Arrays: Practical Consideration and Design Strategies: SPIE 1997.
- [15] Kinsler LE, Frey AR, Coppens AB, Sanders JV; *Fundamentals of Acoustics*, John Wiley & Sons, 1982.
- [16] Gelet JY, Chapelon C, Pangaud, Lanse Y; Local prostate cancer by transrectal high intensity focused ultrasound (HIFU): preliminary results after 113 procedures in 50 patients; *J Urol* 1999; 161: 156-162.
- [17] Hill CR, Haar GR; Review article: High intensity focused ultrasound potential for cancer treatment; *Br J Radiol* 1995; 68: 1296-1303.
- [18] O'Neil TJ; Theory of focusing radiators; *Acoust Soc Am* 1949; 516.
- [19] Pierce AD; *Acoustics: An introduction to its physical principles and applications*; Acoustical Society of America 1994.
- [20] Wells PNT; *Biomedical Ultrasonics*; Academic Press Inc, 1977.
- [21] Haar GR; Ultrasonic contrast agents: safety considerations reviewed; *European Journal of Radiology* 2002; 41: 217.
- [22] Penns HH; Analysis of tissue and arterial blood temperatures in the resting human forearm; *J. Appl. Physiology* 1948; 1: 93.
- [23] Stanczyk M, Telega JJ; Modelling of heat transfer phenomena during cementation of femoral prosthesis; *Acta of Bioengineering and Biomechanics* 2002; 4: 247-248.
- [24] Deuflhard P, Weiser M, Seebass M; A New Nonlinear Elliptic Multilevel FEM in Clinical Cancer Therapy Planning; *Comput Visual Sci* 3 2000; 115-120.
- [25] Kolios MC, Sherar MD, Hunt JW; Blood flow cooling and tissue lesion formation; *Medical Physics* 1996; 23: 1287-1298.
- [26] Chato JC; *Fundamental of Bioheat Transfer in: Thermal Dosimetry and Treatment Planning*, Springer-Verlag, 1991.
- [27] Guy AW, CK Chou; *Hyperthermia in cancer therapy*: Gk Hall Medical Publishers, 1983; 279.
- [1] Sauer A, Wallgren A, Kurtz JM; Adjuvant radiotherapy after breast conserving surgery for breast cancer; *European Journal of cancer* 2000; 36: 1073.
- [2] Hubeer RE, Peter WJ, Jurgen R, Ralf S, Ioannis S, Hans-Peter S, Hans-Joachim VF, Dietrich F, Michael W, Jurgen D; A new non-invasive approach in breast cancer therapy using magnetic resonance imaging-guided focused ultrasound surgery; *Cancer Research* 2001; 61: 8441-8447.
- [3] Kaufma CS, Bachman B, Littrup PJ; Office-based ultrasound guided cryoablation of breast fibroadenomas; *AM J Surg* 2002; 184: 394-400.
- [4] Chen L, Bouley D, Yuh E, Arceuil HD, Butts K; Comparison of focused ultrasound tissue damage on MRI and histology in rabbit brain; *Journal of Magnetic Imaging* 1999; 10: 146.
- [5] Germain D, Chevallier P, Laurent A, Saint-Jalmes H; MR monitoring of tumor thermal therapy; *Magnetic Resonance Materials in Physics, Biology and Medicine* 2001; 13: 47-59.
- [6] Tanaka R, Kim CH, Yamada N, Saito Y; Radiofrequency hyperthermia for malignant brain tumors: preliminary results of clinical trials; *Neurosurgery* 1987; 21: 478-483.
- [7] Terada N, Aoki Y, Ichioka K, Maisuta Y, Arai Y; Microwave thermotherapy for benign prostatic hyperplasia with the Dornier Urowave: Response durability and variables potentially predicting response; *Adult Urology*, 2001; 701.
- [8] Whelan WM, Chun P, Chain L, Sherar MD, Vitkin IA; Laser thermal therapy: Utility of intersittial fluence monitoring for locating optical sensors; *Phys Med Biol* 2001; 46: 91.