

T.C
FIRAT ÜNİVERSİTESİ
FEN BİLİMLERİ ENSTİTÜSÜ

AEROAKUSTİĞİN TEMEL DENKLEMLERİ

Filiz ÖZGEN

YÜKSEK LİSANS TEZİ
MAKİNE MÜHENDİSLİĞİ ANABİLİM DALI

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ELAZIĞ-2000

T.C. FIRAT ÜNİVERSİTESİ, KURULU
BOKUNMAKİNE MÜHENDİSLİĞİ ANABİLİM DALI

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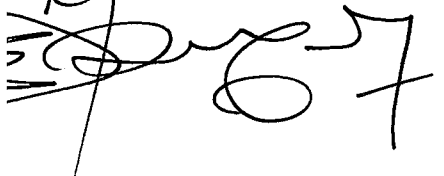
YÜKSEK LİSANS TEZİ
MAKİNE MÜHENDİSLİĞİ ANABİLİM DALI

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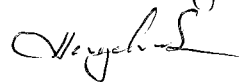
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ÖZET

YÜKSEK LİSANS TEZİ

AEROAKUSTİĞİN TEMEL DENKLEMLERİ

Filiz ÖZGEN

Fırat Üniversitesi

Fen Bilimleri Enstitüsü

Makine Mühendisliği Anabilim Dalı

2000, Sayfa: 104

Aeroakustik, akışkan içinde sesin dağılımı ile ilgilidir. Çalışmamızda aerodinamik gürültü teorisinin anlaşılması için gerekli olan bazı fiziksel düşünceler incelenmiş ve kullanılan temel denklemler çıkarılmıştır. Çıkarılan bu denklemler yardımıyla akışkan içinde yayılan hız, yoğunluk ve basınç değişimleri incelenmiştir. Bu değişimler birer rahatsızlıktır. Rahatsızlıklar çok küçük olduğu için uzun mesafelere yayılmamaktadır.

Akım üniform ve akışkan sıkışamaz kabul edilmiştir. Üniform akım olduğundan x doğrultusundaki değişimlerin yanında y ve z doğrultusundaki değişimlerin ihmal edildiği kabul edilmiştir. Rahatsızlıklar çok küçük ve uzun mesafelere yayılmadığı için viskozitenin ve ısı iletiminin etkisi de ihmal edilmiştir.

Bu çalışmada aeroakustik denklemleri üzerinde durulmuş ve elde edilen rahatsızlık denklemleri Fortran 77 bilgisayar dilinde hazırlanan bir program yardımıyla sonlu farklar metodu kullanılarak sayısal olarak ve Cauchy Teoremi kullanılarak da analitik olarak çözülmüştür. Sonuçlar Δx ve $\Delta \tau$ 'nin arasındaki ilişkiye bağlı olarak eşit ya da farklı alınmıştır. Ayrıca bu sonuçlara uygun grafikler çizilmiş, bu grafiklerde rahatsızlığın dalga halinde küçülerek yayıldığı görülmüştür.

Anahtar Kelimeler: Aeroakustik, rahatsızlık.

ABSTRACT

Master Thesis

BASIC EQUATION OF AEROACOUSTIC

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2000, Page:104

Aeroacoustic is related to the distribution of sound through the fluid. The basic equations of aerodynamic noise theory is reviewed; the pressure, velocity and density distribution in the fluid are investigated by using these equations. These variations are considered to be small so the disturbances aren't diffused long distances.

Main flow is assumed to be uniform and fluid incompressible. Hence the variations in the initial direction of disturbances (x) are noticeable best.

In this study basic equations of aeroacoustics are investigated to obtain the disturbance equations. Then these equations are solved both numerically by using a finite-difference method and analytically. The results are shown graphically and it has been seen that the disturbances are damped wavelly.

Key Words: Aeroacoustic, disturbance.

TESSEKKÜR

Bu gelişmanın yürütülmesinde derin bilgi ve deneyimlerinden yararlandığım başta anısmam hocam Sayın Prof. Dr. Ö. Erkin PERMECI'ye ve bölümümüzün her türlü gelişma nkanından kolaylıkla yararlanmamızı sağlayan Bölüm Başkanımız Sayın Prof. Dr. Kâzım İHTİLİ'ye, projenin her aşamasında manevi desteğini ve dostluğunu sunan sevgili arkadaşım Sayın Arş Gör. Nevin ÇELİK'e ve Neslihan KARAHAN'a teşekkürü borç bilirim.

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SİMGELER LİSTESİ

a	Ses yayılma hızı (m/sn)
c ₀	Temel akım halindeki ses hızı
c'	Rahatsızlıktan meydana gelen ses hızı değişimi
$\tilde{C}$	Temsili dalga yayılma hızı
e	Sabit bir sayı
f	Dalganın frekans değeri (1/sn)
F	Rahatsızlığı oluşturan dış kuvvet
$\overline{F}$	Fourier Transformu işareti
g	Ölçek sabiti
i	Akış doğrultusundaki birim vektör
k	Dalga numarası vektörü
Ma	Mach sayısı
P ₀	Temel akım basıncı
p'	Rahatsızlıktan meydana gelen basınç değişimi
q	Hız ve yoğunluk gradyeni ile orantılı bir büyüklük
r(y ₂ ,y ₃)	Enine koordinat değişkeni
R	Gaz sabiti
s	Entropi
T _p	Dalga periyodu
U	Gerçek akış hızı
u	Temel akım doğrultusunda rahatsızlıktan meydana gelen hız değişimi
u _r	İletim hızı
v ₀	Temel akım doğrultusundaki hız
v	Rahatsızlık sonucu oluşan taşıma hızı
y ₁	Akış doğrultusu
θ ₀	Sıcaklık farkı
φ	Faz fonksiyonu
λ	Dalga boyu
p ₀	Rahatsızlık oluşmadan önceki temel akım yoğunluğu
p'	Rahatsızlıktan meydana gelen yoğunluk değişimi
t	Gecikme zamanı

∇

: Vektör operatörü

ω

: Açılal frekans

γ

: Kaynak terimi

.GİRİŞ

Çalışmamızda bir temel akım (bu sükunet hali de olabilir) mevcut olduğu farz edilerek unun içinde meydana geldiği düşünülen küçük bir rahatsızlığın lineer etkileri incelenmiştir. ir dış kuvvet yardımıyla akışkanın temel akım halindeki özellikleri değiştirilmiştir. aşlangıç halindeki akım özellikleri ile değişim sonucu oluşan özelliklerin arasındaki fark rer rahatsızlıktır ve bu rahatsızlıklar çok küçüktür.

Burada öncelikle rahatsızlık denklemleri çıkarılmış ve bu denklemler sonlu farklar etodu kullanılarak çözülmüştür. Böylece hız, basınç ve yoğunlukla meydana gelen değişimler bulunmuştur.

İAREKETLİ ORTAMIN AKUSTİĞİNİN İNCELENMESİ

. Fiziksel İnceleme

Çalışmamızda bir temel akım olduğu farz edilerek bunun içinde meydana geldiği için rahatsızlıklar incelenmiştir. Akışkan olarak hava göz önüne alınmış ve havanın nel akım halindeki özellikleri uygulanan bir dış kuvvet yardımıyla değiştirilmiştir. Havanın kuvvet uygulanmadan önceki özellikleri ile dış kuvvet uygulandıktan sonra meydana gelen özellikleri arasındaki fark birer rahatsızlıktır. Bu rahatsızlıklar çok küçüktür ve uzun mesafelere yayılmamaktadır.

2. Temel Denklemler

Göz önüne aldığımız akışkan hareketi için Euler denklemlerinin kullanılması yerlidir. Yukarıda belirttiğimiz gibi rahatsızlıklar yeteri kadar küçükse ısı iletimi ve skozitenin etkisi ihmal edilebilir.

Euler denklemleri:

$$\rho \left(\frac{\partial v}{\partial t} + v \nabla v \right) = -\nabla p + F$$

(2.1)

eklinedir. Burada F , dış kuvvetler ve rahatsızlığı temsil etmektedir. F kuvvetinin çok küçük bir zaman aralığında meydana geldiğini ve bir sabit olduğunu kabul ediyoruz.

∇ bir vektör operatörüdür ve;

$$\nabla = i \frac{\partial}{\partial x} + j \frac{\partial}{\partial y} + k \frac{\partial}{\partial z} \text{ şeklindedir.}$$

Süreklilik Denklemi:

$$\frac{\partial \rho}{\partial t} + v \nabla \rho + \rho \nabla v = 0$$

(2.2)

arak verilmektedir. Süreklilik denkleminin pq' ya eşit olması, kontrol yüzeyi üzerinden madde giriş çıkışının mümkün olduğunu gösterir. Burada q boyutsuz bir sayıdır.

Entropi Dengesi:

$$\frac{\partial S}{\partial t} + \nabla S = 0 \quad (2.3)$$

klindedir.

Enerji Denklemi:

$$\frac{\partial p}{\partial t} + \nabla p = \frac{1}{c^2} \left(\frac{\partial p}{\partial t} + \nabla p \right) \quad (2.4)$$

arak verilmektedir.

Yoğunluk, Basınc ve Ses Hızı:

Yoğunluk, basınc ve entropinin bir fonksiyonu olarak düşünülebilir: $p=p(p,S)$. Bunun sonucu olarak;

$$dp = \frac{1}{c^2} dp + \left(\frac{\partial S}{\partial p} \right) dS \quad (2.5)$$

izilebilir. Burada c ses hızının tanımı;

$$c^2 = \frac{1}{\left(\frac{\partial p}{\partial p} \right)} = \left(\frac{\partial p}{\partial p} \right) \quad (2.6)$$

klindedir.

Şimdi yukarıda sözünü ettiğimiz temel akım için bütün büyüklükleri (0) alt indisli ile isterelim; yani hız v_0 , basınç p_0 , entropi $S_0 = S(p_0, p_0)$ ve $c_0 = c(p_0, p_0)$ ile verilsin. (2.1), (2.2), (2.3), ve (2.4) denklemlerinin rahatsızlıklar oluşmadan önceki TEMEL AKIM biçimleri $=0, q=0$;

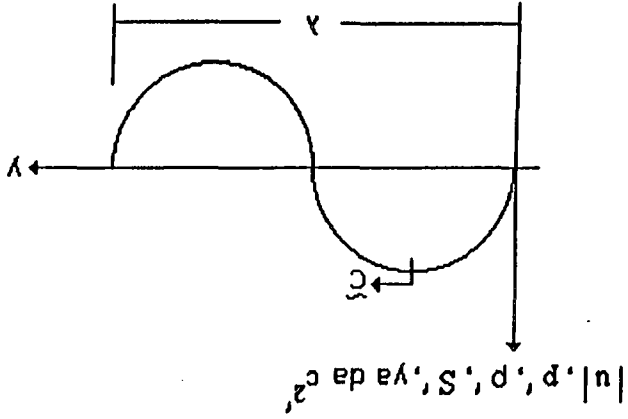
$$\left\{ \begin{array}{l} \rho_0 (v_0 \Delta) v_0 = -\Delta p_0 \\ \Delta p_0 v_0 = 0 \\ v_0 \Delta S_0 = 0 \\ v_0 \Delta p_0 = c_0^2 v_0 \Delta p_0 \end{array} \right.$$

(2.7)

acaktır. Akımın rahatsızlıklar oluştuktan sonraki özelliklerinin p , S , c^2 , p ile verildiğini ve rahatsızlıktan kaynaklanan değişimlerinin de p' , S' , c'^2 , p' ile gösterildiğini düşünürsek rahatsızlıklar çok küçük ve değişimler lineer kabul edildiği için;

$$\begin{aligned} p' &= p - p_0 \\ p' &= p - p_0 \\ S' &= S - S_0 \\ c'^2 &= c^2 - c_0^2 \\ u &= v - v_0 \end{aligned}$$

bul edebiliriz.



Şekil 2.1 Dalga Yayılımı

temsili dalga yayılma hızı λ dalga boyudur. Dalga periyodu $T_p = 1/f$ ile f frekans değeridir ve $f = \frac{c}{\lambda}$ dir. Dolayısıyla yukarıdaki kabuller ışığında,

$$|u| \ll \tilde{c} = \frac{\lambda}{T_p} \quad (2.8)$$

yazabiliriz. Aynı zamanda $p' \ll \langle p_0 \rangle$, $p' \ll \langle p_0 \rangle$, $S' \ll \langle S_0 \rangle$, $c'^2 \ll \langle c_0^2 \rangle$ şeklindedir. Burada $\langle \rangle$, değerlerin Yer Ortalamasını gösterir. Örneğin farklı noktalarda p_1 , p_2 , p_3 gibi ayrı basınçlar mevcut ise bu basınçların yer ortalaması ;

$$\langle p \rangle = \frac{p_1 + p_2 + p_3}{3} \text{ şeklinde tanımlanabilir.}$$

$|u| \ll \tilde{c}$ olduğuna göre $|u|/\tilde{c} = 0$ (ε) mertebesinde dir.

$$0 < \varepsilon \ll 1 \quad (2.9)$$

ve benzer şekilde ;

$$\left\{ \begin{array}{l} |u|/\tilde{c} = 0(\varepsilon) \\ p'/\langle p_0 \rangle = 0(\varepsilon) \\ p'/\langle p_0 \rangle = 0(\varepsilon) \\ S'/\langle S_0 \rangle = 0(\varepsilon) \\ c'^2/\langle c_0^2 \rangle = 0(\varepsilon) \end{array} \right.$$

(2.10)

elde edilir.

Yukarıdaki özelliklerin Zaman Ortalamasını göstermek için $(\bar{})$ ifadesini kullanabiliriz. Zaman Ortalamasını da belirli bir zaman aralığında belirli bir noktada oluşan farklı değerlerin ortalaması olarak tanımlayabiliriz. Örneğin ;

$$\bar{p} = \frac{1}{T} \int_1^0 p(T) dT \text{ , dir.}$$

Böylece denklemlerimizi boyutsuz hale getirmek için;

$$\begin{aligned}
 \bar{\tau} &= \tau/T_p = \tau t \\
 \bar{y}_1 &= y_1/\lambda \\
 \bar{v}_0 &= v_0/C \\
 \bar{p}_0 &= (p_0 - \langle p_0 \rangle) / (\langle p_0 \rangle \langle c_2^0 \rangle) \\
 \bar{p}' &= p' / \langle p_0 \rangle \epsilon \\
 \bar{S}' &= S' / \langle S_0 \rangle \epsilon \\
 \bar{c}'_2 &= c'_2 / \langle c_2^0 \rangle \epsilon \\
 \bar{u} &= u / \tilde{C} \epsilon \\
 \bar{p}_0 &= p_0 / \langle p_0 \rangle \\
 \bar{S}_0 &= S_0 / \langle S_0 \rangle \\
 \bar{c}_2^0 &= c_2^0 / \langle c_2^0 \rangle \\
 \bar{u} &= u / \tilde{C} \epsilon
 \end{aligned}
 \quad (2.11)$$

adesini yazabiliriz. Şimdi bunları ve (2.7) yi (temel akım denklemlerini) kullanarak ,
 1.1),(2.2), (2.3) ve (2.6) denklemlerini boyutsuz hale getirelim,

Süreklilik Denklemi :

$$\frac{\partial p}{\partial t} + v \nabla p + p \nabla v = p q$$

e süreklilik denkleminin temel akım halindeki biçimi $V_p v_0 = 0$ olarak verilmiştir. (2.11)
 denklemlerden $\bar{\tau} = \tau t$ ise $\frac{\partial \tau}{\partial t} = \tau$ tir. Bunu aşağıdaki ifade de yerine yazarsak;

$$\begin{aligned}
 \frac{\partial}{\partial \tau} &= \tau \frac{\partial}{\partial t} \\
 \frac{\partial}{\partial \tau} &= \tau \frac{\partial}{\partial t}
 \end{aligned}$$

ülunur.

Temel Akım için:

$$\frac{\partial p_0}{\partial \tau} + v_0 \nabla p_0 + p_0 \nabla v_0 = p_0 q = 0 \quad (\text{Bu durumda madde üretimi yok.})$$

$$\frac{\partial}{\partial \tau} = \tau \frac{\partial}{\partial t} \text{ olduğundan } \frac{\partial p_0}{\partial \tau} = \tau \frac{\partial p_0}{\partial t} \text{ yazabiliriz. O halde denkleminiz}$$

$$\tau \frac{\partial p_0}{\partial t} + \nabla(p_0 v_0) = 0$$

2) denkleminin tahsisiz akmam için
 $\nabla(p_0 v_0) = 0$ olduğundan $f \frac{\partial p_0}{\partial t} = 0$ olur.

$$f \frac{\partial (p_0 + p')}{\partial t} + (u + v_0) \nabla(p_0 + p') + (p_0 + p') \nabla(u + v_0) = (p_0 + p') q$$

klinde yazılır. Bu son denklemin daha kullanışlı hale getirmek için aşağıdaki işlemleri yapabiliriz.

$$\frac{\partial p_0}{\partial t} + f \frac{\partial p'}{\partial t} + u \nabla p_0 + u \nabla p' + v_0 \nabla p_0 + v_0 \nabla p' + p_0 \nabla u + p_0 \nabla v_0 + p' \nabla u + p' \nabla v_0 = p_0 q + p' q$$

irada;

$$v_0 \nabla p_0 + p_0 \nabla v_0 = \nabla(p_0 v_0) = 0$$

İşinisi ve (2.11) denklemleri yardımıyla

$$f \frac{\partial (p' \langle p_0 \rangle \epsilon)}{\partial t} + \underline{u} \nabla \epsilon \nabla (p_0 \langle p_0 \rangle) + \underline{u} \nabla \epsilon \nabla (p' \langle p_0 \rangle \epsilon) + \underline{v}_0 \nabla \epsilon \nabla (p' \langle p_0 \rangle \epsilon)$$

$$+ (p_0 \langle p_0 \rangle) \nabla (\underline{u} \nabla \epsilon) + (p' \langle p_0 \rangle \epsilon) \nabla (\underline{u} \nabla \epsilon) + p' \langle p_0 \rangle \epsilon \nabla (\underline{v}_0 \nabla \epsilon)$$

$$= p_0 \langle p_0 \rangle q + p' \langle p_0 \rangle \epsilon q$$

de edilir. Gerekti matematik işlemler yapılırsa,

$$\langle p_0 \rangle \epsilon f \frac{\partial p'}{\partial t} + [p_0 \langle p_0 \rangle + p' \langle p_0 \rangle \epsilon] \nabla (\underline{u} \nabla \epsilon) + \underline{u} \nabla \epsilon \nabla (p_0 \langle p_0 \rangle + p' \langle p_0 \rangle \epsilon)$$

$$+ \nabla (p' \langle p_0 \rangle \epsilon \underline{v}_0 \nabla \epsilon) = \langle p_0 \rangle [p_0 q + p' \epsilon q]$$

$$\langle p_0 \rangle \epsilon f \frac{\partial p'}{\partial t} + \langle p_0 \rangle \epsilon [\nabla (p_0 + p' \epsilon) \nabla (\underline{u} + \underline{v}_0 \epsilon) + \underline{u} \nabla (p_0 + p' \epsilon) + \underline{v}_0 \nabla (p_0 + p' \epsilon)] = \langle p_0 \rangle [p_0 q + p' \epsilon q]$$

$$f \frac{\lambda}{\tilde{C}} = J \text{ dan;}$$

$$\frac{\mathcal{Q}^3}{b[\underline{3}, \underline{d} + {}^0\underline{d}]} = [{}^0\underline{\Lambda}, \underline{d} + \underline{n}(\underline{3}, \underline{d} + {}^0\underline{d})] \Delta + \frac{2\varrho}{\underline{d}\varrho} \frac{\gamma}{1}$$

$$b[\underline{3}, \underline{d} + {}^0\underline{d}] = [{}^0\underline{\Lambda}, \underline{d} + \underline{n}(\underline{3}, \underline{d} + {}^0\underline{d})] \Delta \mathcal{Q} + \frac{2\varrho}{\underline{d}\varrho} \frac{\gamma}{\mathcal{Q}} \mathcal{Q}$$

de editur.

$$0 = S\Delta\lambda + \frac{1Q}{S\theta}$$

Emel Akim İçin:

3.3) denklemleri rahatsız edilmemiş akım için

çiminde yazılır.

$$\int \frac{\partial S_0}{\partial t} + \int \frac{\partial S'}{\partial t} + \mathbf{u} \cdot \nabla S_0 + \mathbf{u} \cdot \nabla S' + \mathbf{v}_0 \cdot \nabla S_0 + \mathbf{v}_0 \cdot \nabla S' = 0$$

$\mathbf{v}_0 \cdot \nabla S_0 = 0$ olduğundan;

$$\int \frac{\partial S'}{\partial t} + \mathbf{u} \cdot \nabla S_0 + \mathbf{u} \cdot \nabla S' + \mathbf{v}_0 \cdot \nabla S' = 0 \text{ dir.}$$

11) denklemleri kullanılarak;

$$\int \frac{\partial \langle S' \rangle_{S_0} \langle \epsilon \rangle}{\partial t} + \mathbf{u} \cdot \nabla \langle S' \rangle_{S_0} \langle \epsilon \rangle + \mathbf{u} \cdot \nabla \langle S' \rangle_{S_0} \langle \epsilon \rangle + \mathbf{v}_0 \cdot \nabla \langle S' \rangle_{S_0} \langle \epsilon \rangle = 0$$

lunur. Gerekli matematik işlemler yapıldığında

$$\langle S_0 \rangle \epsilon \frac{\partial \langle S' \rangle}{\partial t} + \langle \tilde{C} \rangle_{S_0} \langle \mathbf{u} \cdot \nabla S_0 \rangle + \langle \tilde{C} \rangle_{S_0} \langle \mathbf{u} \cdot \nabla S' \rangle + \langle \tilde{C} \rangle_{S_0} \langle \mathbf{v}_0 \cdot \nabla S' \rangle = 0$$

ikarida yapıldığı gibi $\lambda = 1$ alınarak rahatsızlık değişkenleri için:

$$\frac{\partial \langle S' \rangle}{\partial t} + \mathbf{u} \cdot \nabla S_0 + \mathbf{u} \cdot \nabla S' + \mathbf{v}_0 \cdot \nabla S' = 0 \quad (2.13)$$

de edilir.

Momentum Denklemi:

$$\rho \left(\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -\nabla p + \mathbf{F}$$

temel akım biçimi $\rho_0 \mathbf{v}_0 \cdot \nabla \mathbf{v}_0 = -\nabla p_0$ olarak verilmiştir.

Temel Akım için:

$$\rho_0 \frac{\partial \mathbf{v}_0}{\partial t} + \rho_0 \mathbf{v}_0 \cdot \nabla \mathbf{v}_0 = -\nabla p_0 + \mathbf{F} \quad (\text{Rahatsızlıklar olmadan önce } \mathbf{F} \text{ kuvveti 0'dır.})$$

$$p_{\text{irr},0} = \frac{20}{0.40} \text{ psia}$$

$$\Delta + ({}^0d + {}^1d)\Delta = \left[({}^0\Lambda + n)\Delta({}^0\Lambda + n) + \frac{{}^1\varrho}{({}^0\Lambda + n)\varrho} \right] ({}^1d + {}^0d)$$
$$J + {}^0\Delta^-, d\Delta^- = \left[{}^0\Delta^0 {}^0\Lambda + n\Delta^0 {}^0\Lambda + {}^0\Delta^0 n + n\Delta^0 n + \frac{12}{{}^0\Lambda^0} J + \frac{12}{n^0} J \right] (d + {}^0d)$$
$$H^{+0} \Delta^+ + {}^d \Delta^- = \left[(\underline{\zeta}^0 \underline{\Delta}) \Delta \underline{\zeta}^0 \underline{\Delta} + (3 \underline{\zeta} \underline{n}) \Delta \underline{\zeta}^0 \underline{\Delta} + (\underline{\zeta}^0 \underline{\Delta}) \Delta 3 \underline{\zeta} \underline{n} + (3 \underline{\zeta} \underline{n}) \Delta 3 \underline{\zeta} \underline{n} + \frac{1}{(3 \underline{\zeta} \underline{n})} \frac{1}{\varrho} J \right] ({}^d + {}^0)$$
$$\begin{aligned} \mathbb{H} + {}^0d\Delta + ,d\Delta - &= (\underline{\zeta}^0 \underline{\mathbb{A}}) \Delta \underline{\zeta}^0 \underline{\mathbb{A}} (,d + {}^0d) + \left[\left\{ \underline{n} \Delta^0 \underline{\mathbb{A}} + ({}^0 \underline{\mathbb{A}} + \mathfrak{A} \underline{n}) \Delta \underline{n} + \frac{\mathfrak{A} \gamma}{\underline{n} \varrho} \right\} \mathfrak{A}_i \underline{\zeta} \right] (,d + {}^0d) \\ \mathbb{H} + {}^0d\Delta + ,d\Delta - &= \left[(\underline{\zeta}^0 \underline{\mathbb{A}}) \Delta \underline{\zeta}^0 \underline{\mathbb{A}} + \underline{n} \Delta \mathfrak{A}_i \underline{\zeta}^0 \underline{\mathbb{A}} + (\underline{\zeta}^0 \underline{\mathbb{A}} + \mathfrak{A} \underline{\zeta} \underline{n}) \Delta \mathfrak{A} \underline{\zeta} \underline{n} + \frac{\mathfrak{A} \gamma}{\underline{n} \varrho} \underline{\zeta} \underline{\zeta} \right] (,d + {}^0d) \end{aligned}$$

$$\begin{aligned}
& \left(\zeta^0_{\underline{A}} \right) \Delta \zeta^0_{\underline{A}} \langle {}^0 d \rangle, \underline{d} - \mathbf{J} \\
& + \left(\mathfrak{z} \langle {}^0 c \rangle \langle {}^0 d \rangle, \underline{d} \right) \Delta - = \left[\underline{n} \Delta^0_{\underline{A}} + ({}^0_{\underline{A}} + \mathfrak{z} \underline{n}) \Delta \underline{n} + \frac{\mathfrak{z} \vartheta}{\underline{n} \vartheta} \frac{\gamma}{1} \right] \left(\mathfrak{z}, \underline{d} + {}^0 \underline{d} \right) \mathfrak{z}_z \zeta \langle {}^0 d \rangle \\
& \left(\zeta^0_{\underline{A}} \right) \Delta \zeta^0_{\underline{A}} \langle {}^0 d \rangle, \underline{d} - \mathbf{J} + , {}^d \Delta - = \\
& \left(\zeta^0_{\underline{A}} \right) \Delta \zeta^0_{\underline{A}} \langle {}^0 d \rangle, \underline{d} - \left(\zeta^0_{\underline{A}} \right) \Delta \zeta^0_{\underline{A}} \langle {}^0 d \rangle {}^0 \underline{d} - \\
& \mathbf{J} + {}^0 d \Delta - , {}^d \Delta - = \left[\left\{ \underline{n} \Delta^0_{\underline{A}} + ({}^0_{\underline{A}} + \mathfrak{z} \underline{n}) \Delta \underline{n} + \frac{\mathfrak{z} \vartheta}{\underline{n} \vartheta} \frac{\gamma}{1} \right\} \mathfrak{z}_z \zeta \right] \left(\mathfrak{z} \langle {}^0 d \rangle, \underline{d} + \langle {}^0 d \rangle {}^0 \underline{d} \right)
\end{aligned}$$

$$\begin{aligned}
(\bar{p}_0 + \bar{p}'\epsilon) \left[\frac{1}{\partial \underline{u}} \frac{\partial}{\partial t} + \underline{u} \nabla (\underline{u} \epsilon + \underline{v}_0) + \underline{v}_0 \nabla \underline{u} \right] + \bar{p}' \underline{v}_0 \nabla \underline{v}_0 &= - \frac{\langle \bar{p}' \epsilon \rangle \langle \bar{c}_2^2 \rangle}{F} + \frac{\langle \bar{p}_0 \rangle \langle \bar{c}_2^2 \rangle}{F} \\
(\bar{p}_0 + \bar{p}'\epsilon) \left[\frac{1}{\partial \underline{u}} \frac{\partial}{\partial t} + \underline{u} \nabla (\underline{u} \epsilon + \underline{v}_0) + \underline{v}_0 \nabla \underline{u} \right] - \bar{p}' \underline{v}_0 \nabla \underline{v}_0 &= - \frac{\langle \bar{p}_0 \rangle \langle \bar{c}_2^2 \rangle}{F} + \frac{\langle \bar{p}' \epsilon \rangle \langle \bar{c}_2^2 \rangle}{F}
\end{aligned}$$

ikarida yapıldığı gibi $\lambda=1$ alınarak
ahatsızlık değişkenleri için;

$$(\bar{p}_0 + \bar{p}'\epsilon) \left[\frac{\partial \underline{u}}{\partial t} + \underline{v}_0 \nabla \underline{u} + \underline{u} \nabla (\underline{v}_0 + \underline{u} \epsilon) \right] + \bar{p}' \underline{v}_0 \nabla \underline{v}_0 = - \frac{\langle \bar{c}_2^2 \rangle}{F} \bar{v}' + \frac{\langle \bar{p}_0 \rangle \langle \bar{c}_2^2 \rangle}{F} \quad (2.14)$$

nklemi bulunur.

Enerji Denklemi:

$$\frac{\partial p}{\partial t} + \underline{v} \nabla p = \frac{1}{\partial p} \left(\frac{\partial p}{\partial t} + \underline{v} \nabla p \right)$$

; temel akım biçimi $\underline{v}_0 \nabla p_0 = \bar{c}_2^2 \underline{v}_0 \nabla p_0$ olarak verilmiştir.

Temel Akım için:

$$\frac{\partial p_0}{\partial t} + \underline{v}_0 \nabla p_0 = \frac{1}{\partial p_0} \left(\frac{\partial p_0}{\partial t} + \underline{v}_0 \nabla p_0 \right)$$

$\underline{v}_0 \nabla p_0 = \bar{c}_2^2 \underline{v}_0 \nabla p_0$ bağıntısı yardımıyla

$$\frac{\partial p_0}{\partial t} + \underline{v}_0 \nabla p_0 = \frac{1}{\partial p_0} \left(\frac{\partial p_0}{\partial t} + \underline{v}_0 \nabla p_0 \right) \Leftrightarrow \frac{\partial p_0}{\partial t} = \frac{1}{\partial p_0} \frac{\partial p_0}{\partial t}$$

erji denklemi rahatsız edilmis akım için;

$$\left[\frac{\partial p_0}{\partial t} + \underline{v}_0 \nabla p_0 \right] = \frac{1}{\partial p_0} \left(\frac{\partial p_0}{\partial t} + \underline{v}_0 \nabla p_0 \right) + \frac{1}{\partial p_0} \left(\frac{\partial p_0}{\partial t} + \underline{v}_0 \nabla p_0 \right)$$

iminde yazılır.

$$f \frac{\partial^2}{\partial p'^2} + n \nabla p_0 + n \nabla p' + v_0 \nabla p_0 + v_0 \nabla p' = \frac{c_z^2}{1} f \left[\frac{\partial^2}{\partial p'^2} + n \nabla p_0 + n \nabla p' + v_0 \nabla p_0 + v_0 \nabla p' \right]$$

(2.11) denklemleri kullanılarak

$$c_z^2 \left[f \frac{\partial^2 \langle p_0 \rangle \langle \epsilon \rangle}{\partial p'^2} + n \tilde{C} \epsilon \nabla \langle p_0 \rangle \langle p_0 \rangle + n \tilde{C} \epsilon \nabla \langle p_0 \rangle \langle p_0 \rangle + v_0 \tilde{C} \nabla \langle p_0 \rangle \langle p_0 \rangle + v_0 \tilde{C} \nabla \langle p_0 \rangle \langle p_0 \rangle \right] \\ = \left[f \frac{\partial^2 \langle p_0 \rangle \langle c_z^0 \rangle \langle \epsilon \rangle}{\partial p'^2} + n \tilde{C} \epsilon \nabla \langle p_0 \rangle \langle c_z^0 \rangle + n \tilde{C} \epsilon \nabla \langle p_0 \rangle \langle c_z^0 \rangle + \langle p_0 \rangle \langle c_z^0 \rangle \right] + c_z^0 v_0 \nabla p_0 + c_z^0 v_0 \nabla p' + c_z^0 \tilde{C} \nabla \langle p_0 \rangle \langle c_z^0 \rangle \langle \epsilon \rangle]$$

bulunur. Gerekli matematiksel işlemler yapıldığında

$$c_z^2 \tilde{C} \langle p_0 \rangle \langle \epsilon \rangle \left[\frac{1}{\partial p'} + n \nabla \langle p_0 \rangle + \epsilon p' + v_0 \nabla p' \right] + c_z^2 \tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle \\ = \langle p_0 \rangle \langle c_z^0 \rangle \langle \epsilon \rangle \left[\frac{1}{\partial p'} + n \nabla \langle p_0 \rangle + \epsilon p' + v_0 \nabla p' \right] + \frac{c_z^0}{1} \tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle \\ = \langle p_0 \rangle \langle c_z^0 \rangle \langle \epsilon \rangle \left[\frac{1}{\partial p'} + n \nabla \langle p_0 \rangle + \epsilon p' + v_0 \nabla p' \right] + \frac{c_z^0}{1} \tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle \\ + \langle c_z^0 \rangle \langle \epsilon \rangle \left[\tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle \right]$$

$$= \langle p_0 \rangle \langle c_z^0 \rangle \langle \epsilon \rangle \left[\frac{1}{\partial p'} + n \nabla \langle p_0 \rangle + \epsilon p' + v_0 \nabla p' \right] + \frac{c_z^0}{1} \tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle \\ + \langle c_z^0 \rangle \langle \epsilon \rangle \left[\tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle \right] + \frac{c_z^0}{1} \tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle \\ = \langle p_0 \rangle \langle c_z^0 \rangle \langle \epsilon \rangle \left[\frac{1}{\partial p'} + n \nabla \langle p_0 \rangle + \epsilon p' + v_0 \nabla p' \right] + \frac{c_z^0}{1} \tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle$$

yukarıda yapıldığı gibi;

$\lambda=1$ alınarak

rahatsızlık değişkenleri için:

$$\left(\frac{c_z^2}{1} \epsilon + \frac{c_z^0}{1} \right) \left[\frac{\partial^2}{\partial p'^2} + n \nabla \langle p_0 \rangle + \epsilon p' + v_0 \nabla p' \right] + \frac{c_z^0}{1} \tilde{C} \langle p_0 \rangle \langle v_0 \nabla p_0 + v_0 \nabla p' \rangle = \left[\frac{\partial^2}{\partial p'^2} + n \nabla \langle p_0 \rangle + \epsilon p' + v_0 \nabla p' \right] \quad (2.15)$$

1. Mertebeden Aero Akustik Yaklaşım Denklemeleri

Böylece yukarıdaki (2.12), (2.13), (2.14) ve (2.15) denklemlerinde e'lu terimleri de hmal ederek, yalnızca rahatsızlık değişkenleri için;

$$(2.16) \quad \left\{ \begin{array}{l} \bar{p}_0 \left(\frac{\partial \bar{u}}{\partial t} + \bar{u}_0 \nabla \bar{u} + \bar{u} \nabla \bar{u}_0 \right) + \bar{p}' \bar{u}_0 \nabla \bar{u}_0 = -\bar{V} \bar{p}' + F \\ \frac{\partial \bar{p}'}{\partial t} + \nabla (\bar{p}_0 \bar{u} + \bar{p}' \bar{u}_0) = \bar{p}_0 q \\ \frac{\partial \bar{S}'}{\partial t} + \bar{u}_0 \nabla \bar{S}' + \bar{u} \nabla \bar{S}_0 = 0 \\ c_0^2 \left(\frac{\partial \bar{p}'}{\partial t} + \bar{u}_0 \nabla \bar{p}' + \bar{u} \nabla \bar{p}_0 \right) + c_0^2 \bar{u}_0 \nabla \bar{p}_0 = \frac{\partial \bar{p}'}{\partial t} + \bar{u}_0 \nabla \bar{p}' + \bar{u} \nabla \bar{p}_0 \end{array} \right.$$

denklemleri bulunur.

Bu denklemlerimiz 1. mertebeden lineer olmayan denklemlerdir. e' lu terimler ihmal edilmeden önceki durum için bilinenler, $\bar{u}_0, \langle c_0^2 \rangle, \langle p_0 \rangle, \bar{S}_0, q$ ve F' dir.

Bilimneyenler ise $\bar{p}', \bar{u}, \bar{p}, \bar{f}, \bar{S}', c^2$ dir. Yani 6 lane bilinmeyen 4 lane de denklemler mevcuttur.

Elde ettiğimiz bu denklemlerden süreklilik denkleminin pq' ya eşit olması kontrol hacmine madde giriş çıkışının olduğunu gösterir. Burada q boyutsuz bir sayıdır.

Momentum denklemlerindeki en önemli ifadelerden biri F kuvvetidir. Çünkü rahatsızlığı oluşturan sadece budur. F kuvveti çok küçük bir zaman aralığında meydana gelir.

Entropi denklemleri diğer denklemlerden bağımsız gibi görünmektedir. Çünkü S' terimi sadece bu denklemlerde mevcuttur.

Enerji denklemleri incelendiğinde p' ile p' nun değişimlerinin (birbirine sabitlerle bağlı olduklarından dolayı) hemen hemen aynı olduğu görülmektedir. Yani enerji alış veriş p' ile p' arasında olmaktadır.

2.3. Tek Yönlü Yanal Doğrultuda Kaymalı, Ortalama Akım

(Oy_1, y_2, y_3) koordinat sisteminde (i,j,k) birim vektörlerini kullanarak temel akım hızının $v_0 = i U(y_1, y_2, y_3)$, olduğunu kabul edelim. i' ye dik doğrultulardaki (y_2, y_3 de) hızların bileşkesini de $u_r (<<U)$ ile gösterebiliriz. p_0, p_0, S_0 in sabit olduğu, y_2 ve y_3 ün de r' nin bir fonksiyonu olduğu kabul edilmektedir. Yani;

$$(2.17) \quad v_0 = i U(r(y_2, y_3)), p_0 = s_l, p_0 = s_l, S_0 = s_l.$$

linmaktadır.

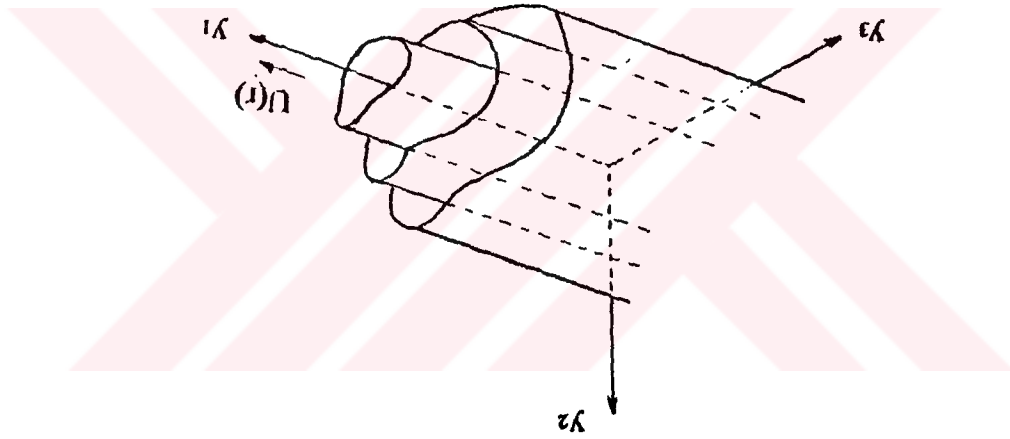
i , y_1 yönündeki birim vektörü göstermektedir. Eline koordinat değişkeni $r(y_2, y_3)$ ters i , y_1 doğrultusundaki y_2 , ve y_3 kartezyen koordinatlarının keyfi bir fonksiyonudur. r ve U nun i zisinde sabit kaldığı yüzeyler silindirik koordinat sisteminin koordinat yüzeyleri gibi düşünülebilir. U daki değişiklikler sadece bu yüzeylerin normali olan Vr doğrultusunda meydana gelir.

Boylece,

$$r = r_0 \equiv \sqrt{y_2^2 + y_3^2}$$

(2.18)

olduğu zaman koordinat yüzeyleri bu kez dairesel silindirik şekle dönüşür ve sonuç olarak $r=r_0$ eşitliği hız profillerinin tamamen radyal olduğunu gösterir.



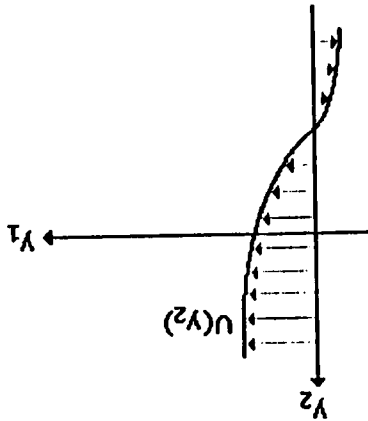
Şekil 2.2. Silindirik Koordinat Sistemi

Öte yandan ;

$$r=y_2$$

(2.19)

olarak alınırsa koordinat yüzeyleri paralel düzlemler gibi olur. Akım şekli Şekil(2.3) deki gibi gösterilebilir.



Şekil 2.3. Paralel Kesitli Ortalama Akış

Genel denklemler hareketli ortamdaki ses dağılımını belirttiğinden genellikle çok amaçlıdır, bu nedenle en basit durumlardan birini yani yukarıda açıklanan tek yönlü akımı ele almak daha yararlı olacaktır.

(2.17) kabulü ve (2.16) denklemleri kullanılarak aşağıdaki denklemler elde edilir.

Momentum Denklemi

$$\rho_0 \left(\frac{\partial u}{\partial t} + v_0 \nabla u + u \nabla v_0 \right) + \rho' v_0 \nabla v_0 = -\nabla p' + F$$

Burada ρ' çok küçük olduğu için ikinci terim ihmal edilebilir. Denklemler,

$$v_0 = i U(r(y_2, y_3)) \text{ yazılırsa,}$$

$$\rho_0 \left(\frac{\partial u}{\partial t} + U \frac{\partial u}{\partial y_1} + U(y_2, y_3) \left(\frac{\partial}{\partial y_2} v_0 + \frac{\partial}{\partial y_3} v_0 \right) \right) = -\nabla p' + F$$

$$\left(\frac{\partial}{\partial t} + \frac{\partial}{\partial y_1} \right) = \frac{d}{dt} \text{ dir.}$$

$$\rho_0 \left(\frac{\partial u}{\partial t} + U \frac{\partial u}{\partial y_1} + u' \frac{d}{dt} \right) = -\nabla p' + F$$

$$\rho_0 \left(\frac{\partial u}{\partial t} + U \frac{\partial u}{\partial y_1} + u' \frac{d}{dt} \right) = -\nabla p' + F$$

bulunur.

$$\frac{D_0}{D} \equiv \frac{\partial}{\partial t} + U \frac{\partial}{\partial y_1} \text{ ve } g(y_2, y_3) = |\nabla r| \text{ olarak veriliyor. Bu durumda,}$$

$$\frac{D_0 \mathbf{u}}{D} \equiv \frac{\partial \mathbf{u}}{\partial t} + U \frac{\partial \mathbf{u}}{\partial y_1} \text{ olur.}$$

Denklem;

$$p_0 \left(\frac{D_0 \mathbf{u}}{D} + i \frac{d}{dt} \mathbf{u}, \mathbf{g} \right) = \nabla p' + F$$

(2.20)

haline gelir.

Süreklilik Denklemi

(2.16)'da süreklilik denklemi

$$\frac{\partial p'}{\partial t} + \nabla(p_0 \mathbf{u} + p' \mathbf{v}_0) = p_0 q$$

biçiminde verilmişti. (2.6) denkleminden hareketle $\frac{\partial p}{\partial t} = \frac{p - p_0}{p} = \frac{p'}{p}$ alınarak $p' = \frac{c_2^0}{p}$

yazılabilir. Bunu süreklilik denkleminde yerine koyar ve p_0 a bölersek;

$$\left(\frac{1}{p} \frac{\partial c_2^0}{\partial t} + \nabla \left(p_0 \mathbf{u} + \frac{c_2^0}{p} \mathbf{v}_0 \right) \right) = p_0 q$$

$$\frac{\partial p}{\partial t} + \nabla p \left(n + \frac{c_2^0 p_0}{p} \right) = p_0 q$$

$$\frac{1}{p} \frac{\partial c_2^0}{\partial t} + \nabla \mathbf{u} + \frac{c_2^0 p_0}{1} \nabla p \mathbf{v}_0 = q$$

$$\frac{1}{p} \frac{\partial c_2^0}{\partial t} + \nabla p \mathbf{v}_0 \left(\frac{\partial}{\partial t} + U \frac{\partial}{\partial y_1} \right) + \nabla \mathbf{u} = q$$

$$v_0 \nabla = U \frac{\partial}{\partial y_1} \text{ ise}$$

$$\frac{1}{p} \frac{\partial c_2^0}{\partial t} + U \frac{\partial}{\partial y_1} \left(\frac{\partial p}{\partial t} + U \frac{\partial}{\partial y_1} \right) + \nabla \mathbf{u} = q$$

$$\frac{\partial p}{\partial t} + U \frac{\partial p}{\partial y_1} = D_0 p \text{ ise}$$

denklemini elde edilir.

$$\frac{1}{D_0 p} \frac{D_0 c_2^2}{D\tau} + \nabla u = q$$

(2.21)

Entropi Denklemi

Yalnızca rahatsızlık değişkenleri için (2.16) denklemlerinde entropi değişimi,

$$\frac{\partial S'}{\partial \tau} + v_0 \nabla S' + u \nabla S_0 = 0$$

şeklinde verilmiştir. S_0 sabit ise $\nabla S_0 = 0$ dir.

$$v_0 \nabla = U \frac{\partial}{\partial y_1} \text{ ise}$$

$$\frac{\partial S}{\partial \tau} + U \frac{\partial S}{\partial y_1} = 0$$

$$\frac{D_0 S}{D\tau} = 0$$

denklemini elde edilir.

(2.22) denklemini entropinin zamanla değişim�ini gösterir. Bu yüzden akım

bölgesinin her yerinde uniform ve sabit entropili akım oluşacaktır. Entropi sabit olduğundan

denklemin (2.5) $dp = \frac{1}{c^2} dp$ olduğunu gösterir.

(2.10) denklemlerinde $c^2 = c_0^2 + 0(e)$ kullanılarak denklemin integre edilirse,

$$\int_1^{p_0} dp = \frac{1}{c_2^2} dp$$

$$p - p_0 = \frac{c_0^2}{p}, \quad p - p_0 = p', \text{ dir.}$$

$$p - p_0 = \frac{c_0^2}{p} = p' \text{ denklemini } p_0 \text{ a bölünürse}$$

$$\left(p - p_0 = \frac{c_0^2}{p} = p' \right) / p_0$$

(2.23)

$$\rho - \rho_0 = \frac{\rho}{\rho - \rho_0} = \frac{\rho_0}{\rho} \frac{\rho_0 c_0^2}{\rho} \equiv \rho'$$

lenklemi bulunur. Şimdi

$$\nabla \frac{D_0 u}{D_0} = \frac{D_0}{D_0} \nabla u + \frac{dU}{dU} g \frac{\partial u}{\partial y_1}$$

(2.24)

ifadesini ele alalım. Bazı matematik işlemler yapacağız.

$$\nabla = \frac{\partial}{\partial} i + \frac{\partial}{\partial} j + \frac{\partial}{\partial} k \quad \text{ise} \quad \frac{\partial}{\partial} j + \frac{\partial}{\partial} k = \frac{d}{d} g r \quad \text{ise}$$

tanımlar ve dolayısıyla;

$$\nabla = \frac{\partial}{\partial} i + \frac{d}{d} g r$$

$$u = v_0 i + u_1 r \text{ ve}$$

$$\frac{D_0}{\partial} = \frac{\partial}{\partial} + U \frac{\partial}{\partial y_1}$$

bağıntıları yardımıyla

$$\left(\frac{\partial}{\partial} i + \frac{d}{d} g r \right) \left[\frac{D_0}{D_0} (v_0 i + u_1 r) \right] = \frac{D_0}{D_0} \left(\frac{\partial}{\partial} v_0 + \frac{d}{d} g u_1 \right) + \frac{dU}{dU} g \frac{\partial u_1}{\partial y_1}$$

$$\frac{\partial}{\partial} \cdot \frac{D_0}{D_0} v_0 + \frac{d}{d} g \frac{D_0}{D_0} u_1 = \frac{D_0}{D_0} \left(\frac{\partial}{\partial} v_0 + \frac{d}{d} g u_1 \right) + \frac{dU}{dU} g \frac{\partial u_1}{\partial y_1}$$

$$\frac{D_0}{\partial} \frac{\partial y_1}{\partial y_1} v_0 + \frac{d}{d} g \left(\frac{\partial}{\partial} u_1 + U \frac{\partial}{\partial y_1} \right) = \frac{D_0}{D_0} \left(\frac{\partial}{\partial} v_0 + \frac{d}{d} g u_1 \right) + \frac{dU}{dU} g \frac{\partial u_1}{\partial y_1}$$

$$\frac{D_0}{\partial} \frac{\partial y_1}{\partial y_1} v_0 + \frac{d}{d} g \frac{\partial \tau}{\partial u_1} + \frac{dU}{dU} g \frac{\partial y_1}{\partial u_1} + \frac{d}{d} g \frac{\partial \tau}{\partial u_1} = \frac{D_0}{D_0} \left(\frac{\partial}{\partial} v_0 + \frac{d}{d} g u_1 \right) + \frac{dU}{dU} g \frac{\partial u_1}{\partial y_1}$$

de edilir.

Burada görünen v_0 hızı taşıma hızı, u_r hızı ise iletim hızı olarak yorumlanabilir. Olayısıyla $v_0 \gg u_r$ dir. Yani iletim hızı taşıma hızından çok büyüktür. Olayısıyla u_r nin v_0 hızından dolayı ihmal edilemez. Ancak r ye göre değişimi ihmal edilebilir. Bundan dolayı, denklemdeki

$$\frac{d}{dt} g \frac{\partial u_r}{\partial r}, g U \frac{d}{dr} \frac{\partial u_r}{\partial y_1} \text{ ve } \frac{d}{dr} g u_r \text{ terimleri ihmal edilebilir.}$$

durumda;

$$D_0 \frac{\partial v_0}{\partial r} + \frac{dU}{dr} g \frac{\partial u_r}{\partial y_1} = D_0 \frac{\partial v_0}{\partial r} + \frac{dU}{dr} g \frac{\partial u_r}{\partial y_1}$$

desi elde edilir. Bu (2.24) ifadesinin doğruluğunu gösterir. Öte yandan (2.20), (2.21) ve (2.24) denklemleri için;

$$\left[\frac{1}{D_0} \frac{D_0}{dt} p + \nabla u = q \right] \text{ denklemi } p_0 \text{ ile çarpılırsa,}$$

$$\frac{1}{D_0} \frac{D_0}{dt} p + p_0 \nabla u = p_0 q$$

İnür. Bu denkleme D_0/Dt operatörü uygulanırsa;

$$\frac{1}{D_0} \frac{D_0}{dt} p + p_0 \nabla u = p_0 \frac{D_0}{dt} q$$

ie edilir. Bu son ifade ile (2.24) arasında $(D_0/Dt) \nabla u$ yok edilirse

$$\frac{D_0}{dt} \nabla u = \nabla \frac{D_0}{dt} u - \frac{dU}{dr} g \frac{\partial u_r}{\partial y_1} \left[\frac{D_0}{dt} u - \frac{dU}{dr} g \frac{\partial u_r}{\partial y_1} \right] = p_0 \frac{D_0}{dt} q$$

ilunur. Benzer şekilde hareket edilerek (2.20) denklemi için,

$$\begin{aligned}
 D_0 \mathbf{u} = -\nabla p + F - i \frac{d\mathbf{r}}{dt} \mathbf{u}_r \mathbf{g} & \left[-\nabla^2 p + \nabla F - \frac{d\mathbf{U}}{dt} \frac{\partial \mathbf{u}_r}{\partial y_1} \mathbf{g} - \frac{d\mathbf{U}}{dt} \mathbf{g} \frac{\partial y_1}{\partial \mathbf{u}_r} \right] = p_0 \frac{D\mathbf{r}}{Dt} \\
 \frac{1}{D_0^2} \frac{D^2 \mathbf{r}}{Dt^2} + p_0 \left[-\nabla^2 p + \nabla F - 2p_0 \mathbf{g} \frac{\partial \mathbf{u}_r}{\partial y_1} \frac{d\mathbf{U}}{dt} \right] & = p_0 \frac{D\mathbf{r}}{Dt} \\
 \nabla^2 p - \frac{1}{D_0^2} \frac{D^2 \mathbf{r}}{Dt^2} + 2p_0 \mathbf{g} \frac{\partial \mathbf{u}_r}{\partial y_1} \frac{d\mathbf{U}}{dt} & = \nabla F - p_0 \frac{D\mathbf{r}}{Dt}
 \end{aligned}
 \quad (2.25)$$

denklemi elde edilir.

U=sbl ise sol taraftaki en son terim düşer ve denklem şu hale gelir.

$$\nabla^2 p - \frac{1}{D_0^2} \frac{D^2 \mathbf{r}}{Dt^2} = \nabla F - p_0 \frac{D\mathbf{r}}{Dt} \equiv -\gamma \quad (2.26)$$

Bu bir sağ taraflı dalga denklemdir. Bu denklemde p ile p' nün arasındaki

$$\frac{p}{p_0} = \frac{p'}{p_0} \Rightarrow p = c_0^2 p'$$

ilişkisi kullanarak p' için;

$$\begin{aligned}
 \nabla^2 (c_0^2 p') - \frac{1}{D_0^2} \frac{D^2 \mathbf{r}}{Dt^2} (c_0^2 p') & = \nabla F - p_0 \frac{D\mathbf{r}}{Dt} \equiv -\gamma \\
 c_0^2 \nabla^2 p' - \frac{D_0^2}{D_0^2} \frac{D^2 \mathbf{r}}{Dt^2} p' & = \nabla F - p_0 \frac{D\mathbf{r}}{Dt} \text{ denklemi } c_0^2 \text{ ye bölünürse} \\
 \nabla^2 p' - \frac{1}{D_0^2} \frac{D^2 \mathbf{r}}{Dt^2} p' & = \frac{1}{c_0^2} \left(\nabla F - p_0 \frac{D\mathbf{r}}{Dt} \right)
 \end{aligned}
 \quad (2.27)$$

denklemi bulunur.

Ayrıca (2.26) denkleminde $U=0$ alınırsa sakın orlam (icmel akım=durağan akışkan) için:

$$\begin{aligned}\nabla^2 p - \frac{1}{D_0^2} D_0^2 p &= \nabla F - p_0 \frac{D_0^2}{D_0^2} \equiv -\gamma \\ \frac{D_0^2}{D_0^2} &= \frac{\partial}{\partial t} + U \frac{\partial}{\partial y_1} \Rightarrow \frac{D_0^2}{D_0^2} \equiv \frac{\partial}{\partial t} \\ \nabla^2 p - \frac{1}{D_0^2} D_0^2 p &= \nabla F - p_0 \frac{D_0^2}{D_0^2} \equiv -\gamma\end{aligned}$$

(2.28)

İnvar. $\nabla^2 p$ yere göre değişimi, $\partial^2 p / \partial t^2$ zamana göre değişimi gösterir. Hızla ilgili olarak;

$$\left(\frac{\partial}{\partial t} \right)_r = \left(\frac{\nabla r}{\nabla} \right) \left(\frac{\nabla r}{\nabla} \right) \text{ yazılabilir. Burada } \frac{|\nabla r|}{\nabla r} = r \text{ birim vektördür.}$$

$$p_0 \left(\frac{D_0^2}{D_0^2} + i \frac{dU}{dt} \nabla r \right) = -\nabla p + F$$

nklemni

$$\frac{r}{\nabla} = \frac{r}{\nabla} \text{ ile skalar olarak çarpalım.}$$

$$\begin{aligned}\frac{r}{\nabla} \nabla &= \frac{r}{\nabla} \left(\frac{\partial}{\partial t} + i \frac{dU}{dt} \nabla r \right) = \frac{dr}{dt} r^2 \\ \frac{d}{dt} r^2 \left[p_0 \left(\frac{D_0^2}{D_0^2} + i \frac{dU}{dt} \nabla r \right) + i \frac{dU}{dt} \nabla r \right] &= -\nabla p + F \\ \frac{d}{dt} p_0 r^2 \frac{D_0^2}{D_0^2} &= -\frac{d}{dt} \frac{\partial p}{\partial t} r^2 + \frac{d}{dt} r^2 F \\ p_0 \frac{D_0^2}{D_0^2} &= -\frac{\partial p}{\partial t} r^2 + F\end{aligned}$$

ile göre (ürev alınığında,

(2.29)

$$p_0 \frac{D_0}{D_0} \frac{\partial u_r}{\partial r} = -g \frac{\partial^2 p}{\partial r^2} + \frac{\partial y_1}{\partial y_1}$$

denklemin bulunur.

(2.25) denklemin D_0/D_r ile birleştirilğinde

$$\left(\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} = \nabla F - p_0 \frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} \right)$$

(2.29) denklemin kullanılarak,

$$\begin{aligned} \left(\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \right) + \left(\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \right) &= \frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \\ \left(\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \right) + \left(\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \right) &= \frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \\ \left(\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \right) + \left(\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \right) &= \frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} \end{aligned}$$

(2.30)

denklemin elde edilir.

(2.31)

$$u_0 = iU(r(y_2, y_3)), \quad p_0 = p_0(r(y_2, y_3)), \quad S_0 = S_0(r(y_2, y_3)), \quad p_0 = st.$$

(2.30) denkleminde $\nabla^2 p$ ve ∇F nin oldugu terim p_0/p_0 ile carpilrsa,

$$\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} = \frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1}$$

(2.32)

$$\frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1} = \frac{D_0}{D_0} \frac{\partial^2 p}{\partial r^2} - \frac{1}{D_0^2} \frac{\partial^2 p}{\partial r^2} + 2p_0 \frac{dr}{du_r} \frac{\partial y_1}{\partial y_1}$$

denklemi bulunur. Viskozite ihmal edildiği için entropi üretimi olmamaktadır. Bu nedenle denklemlerde S_0 görülmeyecektir. Yani gaz ideal gazdır. Dolayısıyla gazın basınç ve yoğunluğu arasındaki $\frac{dp}{p} = n \frac{dp}{p}$ ilişkisi geçerlidir (izantropik hal değişimi). Böyle olunca gaz

çinde ses yayılma hızı $a = \sqrt{nRT}$ denklemi ile verilebilir. Burada $n = \frac{c_p}{c_v}$ orandır. Denklem

2.6)'dan

$$c^2 = \frac{1}{\left(\frac{\partial p}{\partial p}\right)_s}$$

$$\frac{dp}{p} = n \frac{dp}{p} \Leftrightarrow \frac{dp}{p} = n \frac{dp}{p}$$

$$c^2 = n \frac{p}{p_0} = n \frac{p_0 R \theta_0}{p_0}$$

$$c_0 = \sqrt{nR\theta_0}$$

bulunur.

(2.32) denklemi c_0^2 ile carpırsa,

$$\frac{D_0}{D_1} \left(\nabla^2 p - \frac{D_0^2}{D_1^2} p \right) - 2c_0^2 \frac{dU}{dr} g^2 \frac{\partial^2 p}{\partial y^2} = -c_0^2 \gamma \quad (2.33)$$

denklemi elde edilir.

2.4. Akustik Denklemlerinin Dalga Benzeri Çözümleri

Dalga denklemlerinin çözümü için Fourier transformu yönteminden faydalanılabilir.

$t \rightarrow \pm\infty$ aralığı için Fourier transformunun özellikleri de kullanılarak (2.30) denklemi (2.34)

denklemine dönüştürülebilir.

$$\frac{D_0}{D_1} \left(\nabla^2 p - \frac{1}{D_0^2} \frac{D_0^2}{D_1^2} p \right) - 2 \frac{dU}{dr} g^2 \frac{\partial^2 p}{\partial y^2} = \frac{D_0}{D_1} \nabla^2 p - 2 \frac{dU}{dr} g^2 \frac{\partial^2 p}{\partial y^2} - p_0 \frac{D_0^2}{D_1^2} q \equiv -\gamma \quad (2.30)$$

Akman Mach sayısı $M_a = U/c_0$, $k_0 = \omega/c_0$ ve p 'nin Fourier transformu P ile verilmektedir. Fourier transformunun türevine özelliğinden hareketle;

$$\begin{aligned} \mathbb{F}\left[\frac{\partial^2 p}{\partial t^2}\right] &= (-i\omega)^2 \mathbb{F}[p] = -\omega^2 P \\ \frac{D_0}{D_0} \frac{\partial}{\partial t} &= \frac{\partial}{\partial t} + U \frac{\partial}{\partial y_1} \end{aligned}$$

Bu ifadeler (2.30) denkleminde yazılırsa,

$$\left[\frac{\partial}{\partial t} + U \frac{\partial}{\partial y_1} \right] \left[\nabla^2 p - \frac{1}{c_0^2} \left(\frac{\partial}{\partial t} + U \frac{\partial}{\partial y_1} \right) \frac{\partial}{\partial t} \right] p - 2 \frac{dU}{dr} g_z \frac{\partial^2 p}{\partial y_1^2} = 0$$

$$\mathbb{F}\left[\frac{\partial}{\partial t}\right] = -i\omega \text{ ve } U = M_a c_0 \text{ ise}$$

$$\left(-i\omega + M_a c_0 \frac{\partial}{\partial y_1} \right) \left[\nabla^2 p - \frac{1}{c_0^2} \left(-i\omega + M_a c_0 \frac{\partial}{\partial y_1} \right) \frac{\partial}{\partial t} \right] p - 2 \frac{dM_a c_0}{dr} g_z \frac{\partial^2 p}{\partial y_1^2} = 0$$

$\omega = k_0 c_0$ yazılıp gerekli matematik işlemler yapıldığında

$$\left(-ik_0 c_0 + M_a c_0 \frac{\partial}{\partial y_1} \right) \left[\nabla^2 p - \frac{1}{c_0^2} \left(-ik_0 c_0 + M_a c_0 \frac{\partial}{\partial y_1} \right) \frac{\partial}{\partial t} \right] p - 2 \frac{dM_a c_0}{dr} g_z \frac{\partial^2 p}{\partial y_1^2} = 0$$

$$\left(-ic_0 \left(k_0 + iM_a \frac{\partial}{\partial y_1} \right) \right) \left[\nabla^2 p - \frac{1}{c_0^2} \left(c_0 \left(-ik_0 + M_a \frac{\partial}{\partial y_1} \right) \right) \right] p - 2 \frac{dM_a c_0}{dr} g_z \frac{\partial^2 p}{\partial y_1^2} = 0$$

$$\left(-ic_0 \left(k_0 + iM_a \frac{\partial}{\partial y_1} \right) \right) \left[\nabla^2 p - \frac{1}{c_0^2} \left[c_0^2 \left(-ik_0 + iM_a \frac{\partial}{\partial y_1} \right) \right] \right] p - 2 \frac{dM_a c_0}{dr} g_z \frac{\partial^2 p}{\partial y_1^2} = 0$$

$$\left(-i \left(k_0 + iM_a \frac{\partial}{\partial y_1} \right) \right) \left[\nabla^2 p + \left(k_0 + iM_a \frac{\partial}{\partial y_1} \right) \right] p - 2 \frac{dM_a}{dr} g_z \frac{\partial^2 p}{\partial y_1^2} = 0 \quad (2.34)$$

denklemi elde edilir.

1. Durgun Ortamdaki Basit Dalgalar

Ortaman Mach sayısı $M_a=0$ alınıp (2.34) denkleminde yazıldığında Helmholtz

denklemini elde edilir.

$$-\left(k_0 + iM_a \frac{\partial}{\partial y_1}\right) \left[\nabla^2 P + \left(k_0 + iM_a \frac{\partial}{\partial y_1}\right)^2 P \right] - 2 \frac{dM_a}{dr} g_2 \frac{\partial^2 P}{\partial r \partial y_1} = 0$$

İçin $\nabla^2 P = 0$

$$-ik_0 [\nabla^2 P + k_0^2 P] = 0$$

$$\nabla^2 P + k_0^2 P = 0$$

$$(\nabla^2 + k_0^2) P = 0$$

(2.35)

Denklemleri Helmholtz denklemleridir. Denklem (2.28)'in Fourier transformu alınarak da elde edilebilir. $k_0 = \omega/c_0$ bağıntısı yardımıyla Fourier transformunun türetme özelliği de

ullanılarak,

$$\left[\frac{\partial^2 P}{\partial r^2} \right] = (-i\omega)^2 \bar{P} = -\omega^2 P$$

$$\nabla^2 P - k_0^2 \frac{\partial^2 P}{\partial r^2} = 0$$

$$\nabla^2 P - k_0^2 \omega^2 P = 0$$

$\nabla^2 P + k_0^2 P = 0$ şeklinde de bulunabilir. Bu denklem harmonik özelliği olan bir

denklemdir. $\omega \geq 0$ olması durumunda denklemin çözümü $P = Ae^{ik_0 r}$ formundadır. Burada

$k_0 = \omega/c_0$ ve A sabittir. Bundan sonra kaynak süresi t sıfır olursa denklem (2.28)'in

çözümü;

$$P = Ae^{i(k_0 r - \omega t)}$$

(2.36)

şeklinde olur. A sabitine kompleks dalga genliği denir. A 'nın argümanı ise faz sabiti ϕ_0 olarak

belirlenir.

Argüman $(a+ib) = \arctan (b/a)$ dir.

Dalga denkleminin çözümü aslında;

$$P = Ae^{i(k_0 r - \omega t + \phi_0)}$$

şeklinde dir. Burada

$$k_0 y - \omega t + \phi_0 = \phi$$

(2.37)

dir ve faz fonksiyonu olarak adlandırılır.

Hareket halindeki bir dalgada sabit noktaları izlemek için ϕ 'nin sabit alınması gerekir.

Tam titreşim zamanından $\phi = \text{sbt.}$ için,

$$d\phi = \frac{\partial \phi}{\partial y} dy + \frac{\partial \phi}{\partial t} dt = 0$$

$$\frac{\partial \phi}{\partial y} = k_0 \text{ ve } \frac{\partial \phi}{\partial t} = -\omega \text{ ise}$$

$$k_0 dy - \omega dt = 0$$

$$k_0 dy = \omega dt$$

$$\frac{dy}{dt} = \frac{\omega}{k_0} = c_0$$

dir.

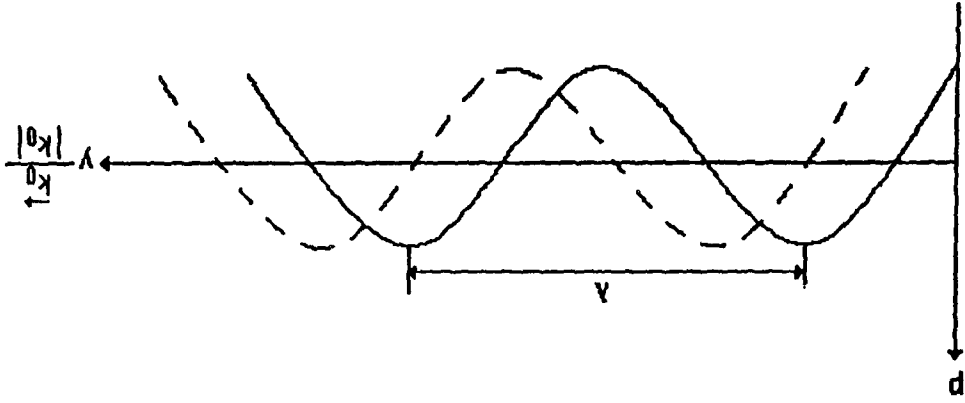
Her y noktasında basınç, zamanın basit bir harmonik fonksiyonu olmalıdır. Oluşan basınç dalgasının açısal frekansı ω , frekansı $f = \omega/2\pi$, ve periyodu $T_p = 1/f$ 'dir. k_0 dalga numarası vektörüdür ve basınç dalgasının hareketli yönündeki birim vektörü göstermektedir.

y_1 ve y_2 gibi farklı iki nokta arasındaki faz farkı;

$$\phi_1 = k_0 y_1 - \omega t + \phi_0$$

$$\phi_2 = k_0 y_2 - \omega t + \phi_0$$

$\phi_1 - \phi_2 = k_0(y_1 - y_2)$ sabittir ve zamandan bağımsızdır.



Şekil 2.4. t zamanından $1/4$ periyot sonraki düzlem dalga dağılımı

λ dalga boyudur. $t=t_0$ olduğu anda k_0 doğrultusunda şekil (2.4)'de kavisli çizgiyle gösterilen yönde değişen değerler alır. Bir periyodun $1/4$ 'ü kadar süre geçtikten sonra dalga bu kez şekilde kesikli çizgi ile gösterilen duruma gelir. ϕ =sabit yüzeylerinin her biri bir faz yüzeyi olarak adlandırılır. Bu yüzeyler k_0 doğrultusuna dik olmalıdır ve dalgayla birlikle şekil (2.5)'de görüldüğü gibi hareket etmelidir. Benzer bir durum da ω 'nin sıfırdan küçük olduğu zaman görülür. Fakat o zaman $[k]$, $-\omega/c_0$ 'a eşit olacaktır ve dalga $-k_0$ yönünde çıkacaktır. Denklem (2.28) incec olduğundan $y=0$ halinde bir dalga düzlemi birleşiminin çözümünün (2.36) olması gerektiği kolaylıkla görülmektedir.

$$\phi_1 = k_0 y_1 - \omega t + \phi_0$$

$$\phi_2 = k_0 y_2 - \omega t + \phi_0$$

$$\phi_1 + \phi_2 = k_0 (y_1 + y_2) - 2\omega t + 2\phi_0$$

Bu çözümlerin sayısı daha fazla olabilir. Çözümlerin toplanabilirliğini (super pozisyon) şu şekilde de gösterebiliriz.

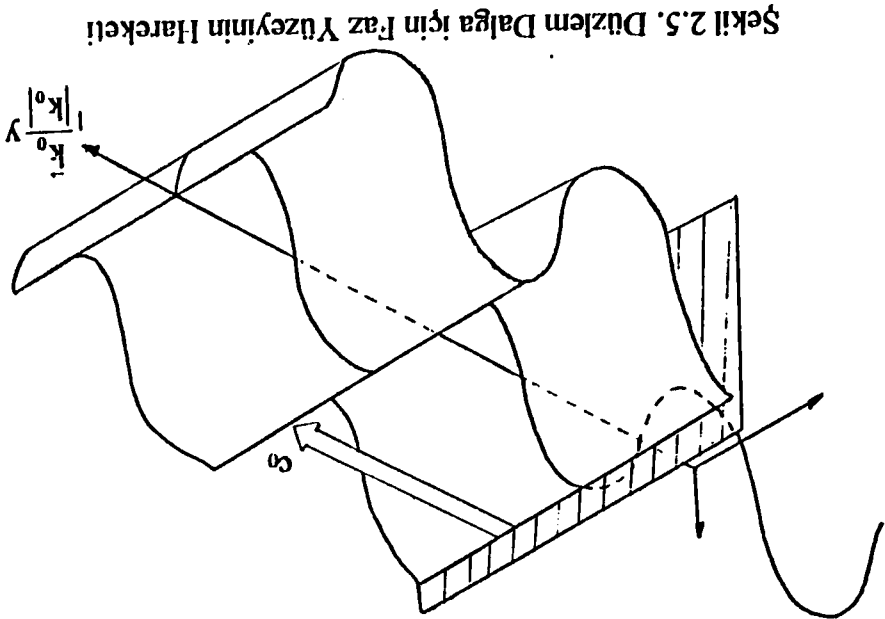
(2.36) çözümünden hareketle

$$p = \sum_{j=1}^{\infty} \sum_{j=1}^{\infty} A e^{ik_0 y_j - i\omega_j t}$$

Bu toplam integral biçiminde,

$$p = \iint A(k_0) e^{i(k_0 y - \omega t)} dK_0 d\omega$$

olarak yazılabilir. Burada $\omega = c_0 k_0$ ve $K_0 = \frac{k_0}{k_0}$ dir.



Şekil 2.5. Düzlem Dalga için Faz Yüzeyinin Hareketi

(2.38)

SAKIN AKIŞKAN HALİNDE RAHATSIZLIK DAĞILIMI İÇİN BASİT ÇÖZÜMLER

Rahatsızlık değişkenleri için denklemlerimiz :

(NOT : 3. Bölümden itibaren yazım kolaylığı olması açısından ' işaretli konulmamıştır.)

$$(3.1) \quad \left\{ \begin{array}{l} \rho_0 \left(\frac{\partial u}{\partial t} + v_0 \Delta u + u \nabla v_0 \right) + p v_0 \nabla v_0 = -\nabla p + F \\ \frac{\partial p}{\partial t} + \nabla(p_0 u + p v_0) = p_0 q \\ \frac{\partial S}{\partial t} + v_0 \Delta S + u \nabla S_0 = 0 \\ c_0^2 \left(\frac{\partial p}{\partial t} + v_0 \Delta p + u \nabla p_0 \right) + c_0^2 v_0 \Delta p_0 = \frac{\partial p}{\partial t} + v_0 \Delta p + u \nabla p_0 \end{array} \right.$$

arak bulunmuştur.

$v_0 = sl.$, $p_0 = sl.$ ve $p_0 = sl.$ alındığında yukarıda verilen rahatsızlık denklemleri şu hale gelir:

$$(3.2) \quad \left\{ \begin{array}{l} \rho_0 \left(\frac{\partial u}{\partial t} + v_0 \Delta u \right) = -\nabla p + F \\ \frac{\partial p}{\partial t} + p_0 \Delta u + v_0 \Delta p = p_0 q \\ c_0^2 \left(\frac{\partial p}{\partial t} + v_0 \Delta p \right) = \frac{\partial p}{\partial t} + v_0 \Delta p \end{array} \right.$$

Akışkan sakin olduğuna göre $v_0 = 0$ alındığında rahatsızlık denklemleri aşağıdaki gibi

asileştirilebilir:

Momentum denklemleri;

$$\rho_0 \frac{\partial u}{\partial t} = -\frac{\partial p}{\partial x} + F$$

ir. Buradan,

$$\frac{\partial u}{\partial t} = -\frac{1}{F} \frac{\partial p}{\partial x} + \frac{p_0}{F} \frac{\partial x}{\partial t} \quad (3.3)$$

benzer şekilde süreklilik denklemleri,

$$\frac{\partial p}{\partial t} + p_0 \frac{\partial u}{\partial x} = p_0 q$$

$$\frac{\partial p}{\partial t} = -p_0 \frac{\partial u}{\partial x} + p_0 q \quad (3.4)$$

bulunur.

Enerji denklemleri;

$$c_0^2 \frac{\partial p}{\partial t} = \frac{\partial \tau}{\partial t}$$

$$\frac{\partial p}{\partial t} = \frac{1}{c_0^2} \frac{\partial \tau}{\partial t} \quad (3.5)$$

ilde edilir. Bu denklem τ 'ya göre integre edilirse;

$$\overline{p} \approx c_0^2 p \quad (3.6)$$

bulunur. (3.4) ve (3.5) denklemleri kullanılarak;

$$\frac{1}{c_0^2} \frac{\partial \tau}{\partial t} = -p_0 \frac{\partial u}{\partial x} + p_0 q$$

$$\frac{\partial p}{\partial t} = -c_0^2 p_0 \frac{\partial u}{\partial x} + p_0 q c_0^2 \quad (3.7)$$

denklemi bulunur. (3.3) denklemleri;

$$\frac{\partial p}{\partial x} = -\rho_0 \frac{\partial u}{\partial \tau} + F \quad (3.8)$$

elde edilir. (3.7) denkleminin x 'e göre, (3.8) denkleminin τ 'ya göre türevi alınıp, taraf tarafa çıkarılırsa,

$$\begin{aligned} \frac{\partial}{\partial x} \left(-c_0^2 \rho_0 \frac{\partial u}{\partial x} \right) &= \frac{\partial p}{\partial \tau} - \rho_0 q c_0^2 \\ -c_0^2 \rho_0 \frac{\partial^2 u}{\partial x^2} &= \frac{\partial^2 p}{\partial x \partial \tau} \\ \text{ve} \\ \frac{\partial}{\partial \tau} \left(-\rho_0 \frac{\partial u}{\partial \tau} + F \right) &= \frac{\partial p}{\partial x} \\ -\rho_0 \frac{\partial^2 u}{\partial \tau^2} &= \frac{\partial^2 p}{\partial \tau \partial x} \\ \frac{\partial^2 u}{\partial \tau^2} - c_0^2 \frac{\partial^2 u}{\partial x^2} &= 0 \end{aligned} \quad (3.9)$$

denklemini elde edilir.

Elde ettiğimiz (3.6), (3.8), (3.9) denklemlerinin çözümü için iki yol vardır. Bunlar, sonlu farklar metodu kullanılarak yapılan sayısal çözüm ve analitik çözümdür.

3.1. Analitik Çözüm

3.1. 1. Riemann Çözümü

(3.9) denklemini hiperbolik bir denklemdir ve bu denklem analitik olarak Cauchy Teoremi kullanılarak çözülebilir. Başlangıç şartlarını koşarak Cauchy ya da ilk değer problemini vaz edebiliriz. Başlangıç şartları;

$$0 \leq x \leq L \text{ ve } \tau=0 \text{ 'da } \begin{cases} u(x,0) = f(x) \\ \frac{\partial u(x,0)}{\partial \tau} = g(x) \end{cases}$$

olarak verildiğinde analitik çözüm;

$$u(x, \tau) = \frac{1}{2} [f(x + c_0 \tau) + f(x - c_0 \tau)] + \frac{1}{2c_0} \int_{x-c_0\tau}^{x+c_0\tau} g(y) dy$$

şeklindedir.

3.1.2. Değişkenlere Ayırma Yöntemi

İkinci bölümde, durgun ortamdaki basit dalgalar incelenirken Helmholtz denkleminin çözümünün

$$p = Ae^{i(k_0 y - \omega \tau)}$$

formunda olduğu belirtilmişti. Bu çözümden hareketle basınç, hız ve yoğunluk değişimlerinin hesabı için tahmini çözüm fonksiyonları oluşturulabilir. a , b , f , h sabitler olmak üzere tahmini çözüm fonksiyonları aşağıdaki gibi olsun:

$$\left. \begin{aligned} p &= p_0 e^{ax + b\tau} \\ u &= v_0 e^{fx + h\tau} \end{aligned} \right\} \quad (3.10)$$

Bu çözümler (3.8) ve (3.9) denklemlerinde yerine yazılıp türev alma işlemleri yapılırsa

$$\begin{aligned} \frac{\partial p}{\partial x} &= -\rho_0 \frac{\partial u}{\partial \tau} + F \\ p_0 a e^{ax + b\tau} &= -\rho_0 v_0 h e^{fx + h\tau} + F \end{aligned} \quad (3.11)$$

bulunur. Benzer şekilde,

$$\begin{aligned} \frac{\partial^2 u}{\partial \tau^2} - c_0^2 \frac{\partial^2 u}{\partial x^2} &= 0 \\ v_0 h^2 e^{fx + h\tau} - c_0^2 v_0 f^2 e^{fx + h\tau} &= 0 \end{aligned}$$

olduğundan,

$$\begin{aligned} h^2 &= c_0^2 f^2 \\ h &= c_0 f \end{aligned} \quad (3.12)$$

olarak bulunur. Şimdi verilen sabitlere keyfi değerler vererek çözümler bulalım.

Cözüm 1:

$x=0, \tau=0$ 'da $b=0, f=1$ için (3.11) denkleminde;

$$p_0 a e^{ax+b\tau} = -\rho_0 v_0 h e^{fx+h\tau} + F$$

$$p_0 a = -\rho_0 v_0 h + F$$

$$h = c_0 f$$

olduğundan $f=1$ ise $h=c_0$ 'dır.

$$p_0 a = -\rho_0 v_0 c_0 + F$$

$$a = \frac{-\rho_0 v_0 c_0 + F}{p_0} \quad (3.13)$$

olarak bulunur. Bu durumda çözüm kümesi;

$$p = p_0 e^{\frac{-\rho_0 v_0 c_0 + F}{p_0} x}$$

$$u = v_0 e^{x+c_0 \tau}$$

şeklindedir.

Cözüm 2:

$X=0, \tau=0$ 'da $b=0$ ve $f=0$ için,

$$p_0 a e^{ax+b\tau} = -\rho_0 v_0 h e^{fx+h\tau} + F$$

$$h = c_0 f \Rightarrow f = 0 \text{ için } \rightarrow h = 0 \text{ 'dır}$$

$$p_0 a = F$$

$$a = \frac{F}{p_0} \quad (3.14)$$

bulunur. Bu durum için çözüm kümesi:

$$p = p_0 e^{\frac{F}{p_0} x}$$

$$u = v_0$$

şeklindedir. Bu çözüm fiziksel olarak uygun bir çözüm değildir. Çünkü hızdaki değişim rahatsızlıktan önceki hız değerine eşit olamaz ($v=v_0$). O halde bu çözüme bağlı olarak sınır şartları seçilmemelidir. Başlangıç şartları için seçtiğimiz $f(x)$ ve $g(x)$ fonksiyonları farklı çözüm kümeleri oluşturacaktır. Yukarıda da görüldüğü gibi oluşan çözüm kümeleri doğru ya da yanlış olabilir.

3.2. Sonlu Farklar Metodu

Yakınsamanın kararlı bir şekilde olmasını sağlamak amacıyla sonlu farklar metodu kullanılabilir. Elde ettiğimiz (3.6), (3.8), (3.9) denklemlerini sonlu fark denklemlerine dönüştürebilmek için;

$$\left(\frac{\partial u}{\partial \tau}\right)_{i,j} = \frac{u_{i,j} - u_{i,j-1}}{\Delta \tau} \quad (3.15)$$

$$\left(\frac{\partial p}{\partial x}\right)_{i,j} = \frac{p_{i,j} - p_{i-1,j}}{\Delta x} \quad (3.16)$$

$$\left(\frac{\partial^2 u}{\partial x^2}\right)_{i,j} = \frac{u_{i+1,j} - 2u_{i,j} + u_{i-1,j}}{\Delta x^2} \quad (3.17)$$

$$\left(\frac{\partial^2 u}{\partial \tau^2}\right)_{i,j} = \frac{u_{i,j+1} - 2u_{i,j} + u_{i,j-1}}{\Delta \tau^2} \quad (3.18)$$

ifadeleri kullanılabilir. Bu ifadeler yazıldıktan sonra sonlu fark denklemleri kolaylıkla bulunur.

(3.9) denklemi için sonlu fark denklemini şu şekilde yazabiliriz:

$$\frac{\partial^2 u}{\partial \tau^2} - c_0^2 \frac{\partial^2 u}{\partial x^2} = 0$$

(3.17) ve (3.18) ifadeleri yardımıyla

$$\frac{u_{i,j+1} - 2u_{i,j} + u_{i,j-1}}{\Delta \tau^2} - c_0^2 \frac{u_{i+1,j} - 2u_{i,j} + u_{i-1,j}}{\Delta x^2} = 0$$

bulunur. Buradan,

$$u_{i,j+1} = (2u_{i,j} - u_{i,j-1}) + \left(\frac{c_0 \Delta \tau}{\Delta x}\right)^2 (u_{i+1,j} - 2u_{i,j} + u_{i-1,j}) \quad (3.19)$$

bulunur. Benzer şekilde (3.15) ve (3.16) ifadeleri kullanılarak (3.8) denklemi sonlu fark biçiminde aşağıdaki gibi yazılabilir.

$$\frac{\partial p}{\partial x} = \rho_0 \frac{\partial u}{\partial \tau} + F$$

$$\frac{p_{i,j} - p_{i-1,j}}{\Delta x} = -\rho_0 \frac{u_{i,j} - u_{i,j-1}}{\Delta \tau} + F$$

Buradan,

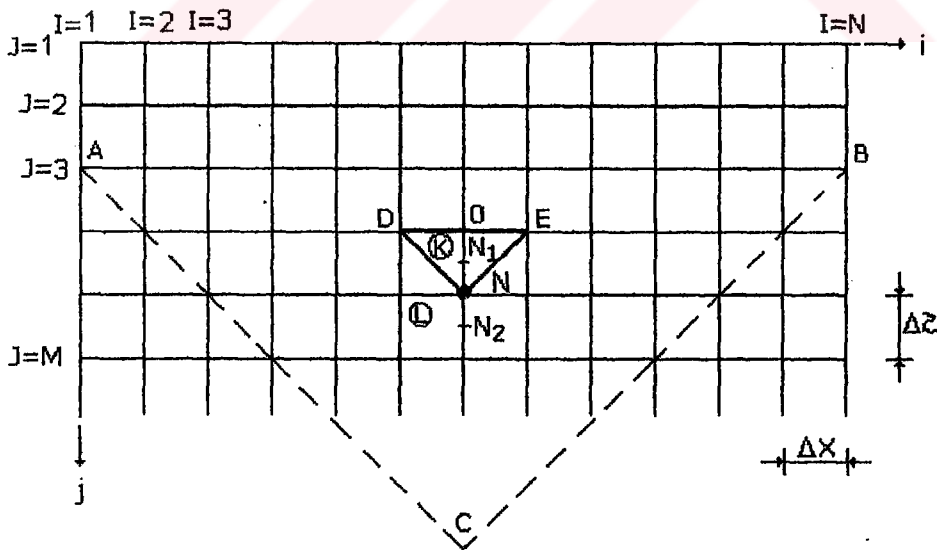
$$p_{i,j} = \frac{-\rho_0 \Delta x}{\Delta \tau} (u_{i,j} - u_{i,j-1}) + F \Delta x + p_{i-1,j} \quad (3.20)$$

bulunur.

Elde edilen sonlu fark denklemleri Fortran 77 bilgisayar dilinde hazırlanan bir program yardımıyla sayısal olarak çözülmüştür.

3.2.1. Sınır Şartları ve Sayısal Çözüm Yöntemi

Rahatsızlık bir noktadan başlayıp simetrik olarak yayılmaktadır. Verilen sınır şartlarına uygun bir çözüm elde edebilmek için rahatsızlığın olduğu alan keyfi sayıda parçalara bölünmüştür. Rahatsızlığın dağılımını ve sınır şartlarını Şekil 3.1'de görebiliriz.



Şekil 3.1. Rahatsızlığın Dağılımı

$I=N$ ve $J=M$ noktaları rahatsızlığın sona erdiği noktalardır ve bu noktaların sayısı arttırılabilir. Arttırıldığı takdirde uzak noktalardaki rahatsızlık değerleri daha kolay bulunabilir.

Hız hesabını yapabilmek için daha önce bulduğumuz,

$$u_{i,j+1} = (2u_{i,j} - u_{i,j-1}) + \left(\frac{c_0 \Delta \tau}{\Delta x} \right)^2 [u_{i+1,j} - 2u_{i,j} + u_{i-1,j}]$$

denklemini ilk şartlardan yararlanmak amacı ile $J=2$ için yazalım:

$$u_{i,3} = (2u_{i,2} - u_{i,1}) + \left(\frac{c_0 \Delta \tau}{\Delta x} \right)^2 [u_{i+1,2} - 2u_{i,2} + u_{i-1,2}]$$

$u_{i,3}$ değerini bulabilmek için $u_{i,2}$ değerine ilaveten, bölgemizin dışında kalan $u_{i,1}$ değerlerine ihtiyacımız vardır.

$u_{i,2}$ değerleri verilen başlangıç değerlerinden,

$$u_{i,2} = f(x)$$

olarak bulunabilmektedir. $u_{i,1}$ değerleri için ikinci başlangıç şartı kullanılabilir. Bu düşünce ile $\partial u / \partial x$ ifadesini sonlu fark biçiminde teşkil etmeliyiz:

$$\left(\frac{\partial u}{\partial x} \right)_{i,2} = \frac{u_{i,2} - u_{i,1}}{\Delta x} = g(x)$$

Buradan,

$$\begin{aligned} u_{i,1} &= u_{i,2} - \Delta x \cdot g(x) \\ u_{i,1} &= f(x) - \Delta x \cdot g(x) \end{aligned}$$

elde edilir. Bu durumda çözümün elde edilmesi mümkündür. $u_{i,3}$ elde edildikten sonra $u_{i,4}$, $u_{i,5}$,..... sırası ile ve kolayca hesaplanabilir. Böylece rahatsızlığın olduğu ABC bölgesi içinde kalan tüm noktalar için hız değerleri bulunmuş olur.

Basınç hesabı için:

$$p_{i,j} = \frac{-\rho_0 \Delta x}{\Delta \tau} (u_{i,j} - u_{i,j-1}) + F \Delta x + p_{i-1,j}$$

$$p_{i,j} - p_{i-1,j} = \Delta p$$

alınırsa,

$$\Delta p = \frac{-\rho_0 \Delta x}{\Delta \tau} (u_{i,j} - u_{i,j-1}) + F \Delta x$$

denklemden faydalanılabilir. Şekil 3.1’de görülen ABC rahatsızlık alanı dışında kalan tüm bölgelerde basınç sabittir. Tüm noktalar için hız hesabı yapıldıktan sonra basınç hesabı da bu denklem sayesinde yapılabilir.

Rahatsızlığın olduğu bölgenin dışında yoğunluk sabittir ve ρ_0 değerindedir. Çünkü akışkan sıkışamaz ve akım üniform kabul edilmiştir. Daha önceden elde ettiğimiz $p \sim c_0^2 \rho$ ifadesinden de görüldüğü gibi basınç ve yoğunluk birbirine ses hızı ile bağlıdır. Ses hızı bilindiği takdirde, basınç değerine bağlı olarak yoğunluğun değeri bulunabilir.

Hız, basınç ve yoğunluk değerleri Fortran 77 bilgisayar dilinde hazırlanan bir program yardımıyla sayısal olarak bulunmuştur. Farklı başlangıç şartları ve Δx , $\Delta \tau$ ’nun farklı değerleri için bilgisayar sonuçları incelenmiş ve $c \cdot \Delta x \geq \Delta \tau$ olması gerektiği görülmüştür. Aslında bu hiperbolik denklemlerin bir sonucudur.

Kullandığımız hiperbolik denklemlerin karakteristik doğruları $x \pm ct = st$ doğrularıdır. Şekil (3.1)’de görülen bir N noktası düşündüğümüzde, bu noktadan geçen $x \pm ct = st$ doğruları çözüm bölgesini K ve L bölgelerine ayırmaktadır. N noktasının hesaplanması için $0 \leq x \leq N$ üzerinde verilmiş olan başlangıç şartlarının tümü değil, sadece DE üzerindeki bölümü gerekli ve yeterli olmaktadır. Bu nedenle K bölgesine N noktasının “Bağımlılık Bölgesi” adı verilmektedir. Benzer şekilde N noktasındaki değerlere bağımlı olan bütün noktalar da L bölgesi içerisinde yer almakta ve bu nedenle E bölgesine N noktasının “Etki Bölgesi” adı verilmektedir.

SONUÇLAR

Daha önce de belirttiğimiz gibi çalışmamızda akışkan olarak hava göz önüne alınmıştır. Akışkan sıkışamaz ve akım uniform kabul edilmiştir. Akışkan sıkışamaz olduğundan $\rho_0 = \text{st}$ ve akım uniform olduğu için de akım doğrultusundaki değişimler incelenmiştir. Rahatsızlık çok küçük kabul edildiğinden viskozitenin etkisi ihmal edilmiştir.

Δx , rahatsızlığın yayıldığı kabul edilen x doğrultusundaki birim mesafeyi göstermektedir. Δt da zaman dilimidir. Rahatsızlık uzun mesafelere yayılmayacağından Δx , benzer şekilde uzun süreli olmayacağından Δt küçük değerler alacaktır.

Denklemlerimizde geçen ses hızı c_0^2 boyutsuzdur. Boyutsuzlaştırma işlemi 2. Bölümde geçen (2.11) denklemlerinden $\bar{c}_0^2 = c_0^2 / \langle c_0^2 \rangle$ ifadesi kullanılarak yapılmıştır. $\langle c_0^2 \rangle$ ses hızının yer ortalamasını göstermektedir. O halde $\langle c_0^2 \rangle$, c_0^2 'ye yakın ya da eşit bir değer olacaktır. Bu durumda $c_0^2 / \langle c_0^2 \rangle$ oranı yani $\bar{c}_0^2$ 1 ya da 1'e yakın bir değer alacaktır. Benzer şekilde $\bar{\rho}_0 = \rho_0 / \langle \rho_0 \rangle$ olduğundan $\bar{\rho}_0$ da 1 ya da 1'e yakın bir değer olacaktır.

Rahatsızlığı oluşturan temel unsur kuvvettir. Rahatsızlıklar çok küçük olduğu için, onu oluşturacak olan F kuvveti de çok küçük olmalıdır.

Δx ve Δt 'nin farklı değerleri için bilgisayar sonuçları incelendiğinde c. $\Delta x \geq \Delta t$ olması gerektiği görülmüştür. Daha önceden belirttiğimiz gibi bir noktadaki değerlerin hesabı, o noktaların bağımlılık bölgesi içinde kalan değerlere bağlıdır. Bağımlılık bölgesi dışında kalan değerler çözüm için kullanılmaz. Şekil 3.1'de görülen N noktasının hesaplaması için sadece DE doğrusu üzerindeki şartlar gerekli ve yeterlidir. $ON = \Delta t$ ise $DE = 2\Delta x$ 'dir. yani N noktası için DE 'deki tüm bilgiyi kullanmak üzere $\Delta x = \Delta t$ seçmiş oluyoruz. Şimdi NDE bölgesi içinde bir N_1 noktasını düşünelim. N_1 noktası D ve E 'nin etki bölgesi içindedir DE üzerindeki bilgiler yardımıyla hesaplanabilir. Bölge dışında kalan başka bir N_2 noktasının çözümü için DE 'deki bilgi yeterli olmayabilir. O halde bu hiperbolik denklemin çözümü için $c\Delta x \geq \Delta t$ almamız gerek ve şarttır.

Denklemlerimiz farklı sınır şartları altında sayısal ve analitik olarak çözülmüştür. Elde edilen sonuçlar Ek-2' de verilmiştir. Bu sonuçlar sırasıyla hızın sonlu farklar metodu kullanılarak bulunan sonuçlarını, analitik çözüm sonuçlarını, hemen ardından aradaki izafi hataları ve basınç değerini göstermektedir. Görülmüştür ki $c\Delta x \geq \Delta t$ alınması sayısal ve analitik çözümlerin birbirine yakın olmasını sağlamıştır. Aksi durumda ise sonuçlar tamamen hatalıdır. Ayrıca her bir sınır şartı için birer grafik çizilerek Ek-3' de verilmiştir. Grafikler incelendiğinde rahatsızlığın dalga halinde küçülerek yayıldığı görülmüştür.

KAYNAKLAR

Goldstein, M.E., (1976), Aeroacoustics.

Peremeci, Ö.E., (1983), Sayısal Deney Yöntemleri.



EK-1

```

C*****
C*** BU PROGRAM RAHATSIZLIK DENKLEMLERININ*****
C*****SONLU FARKLAR METODUYLA SAYISAL COZUMUNU VE *****
C*****ANALITIK COZUMUNU YAPAR*****
C*****

      PARAMETER(M=11,N=11)
      DIMENSION U(M,N),GD(M,N),H(M,N),P(M,N),RO(M,N)
      DIMENSION UI(M,N)
      OPEN(1,FILE='FILIZ.DAT')
      WRITE(*,*)'TDX I GIRINIZ'
      READ(*,*)TDX
      WRITE(*,*)'TDTO YU GIRINIZ'
      READ(*,*)TDTO
      WRITE(*,*)'C YI GIRINIZ'
      READ(*,*)C
      WRITE(*,*)'F I GIRINIZ'
      READ(*,*)F
      WRITE(*,*)'RO0 I GIRINIZ'
      READ(*,*)RO0
      WRITE(*,*)'P0 I GIRINIZ'
      READ(*,*)P0
      D=(TDTO/TDX)**2
      WRITE(1,*) D
      WRITE(1,12) TDX,TDTO,C,F,RO0,P0
12  FORMAT( 'TDX=',F5.2/ 'TDTO=',F5.2/ 'C=',F5.2
          */ 'F=',F5.2/ 'RO0=',F5.2/ 'P0=',F5.2)
C*****
C  SINIR SARTI
C*****

      DO 29 I=1,N
      P(I,1)=P0
      P(I,2)=P0
      RO(I,2)=RO0

```


RO(I,1)=RO0

U(I,2)=EXP((-TDX*(I-1)))

C*****

C U(I,2)=(SIN(TDX*(I-1))*0.0174)

C U(I,1)=U(I,2)+TDX*(EXP(-TDX*(I-1)-C))

C*****

C U(I,1)=U(I,2)-TDX*(-EXP(-TDX*(I-1)-C))

C*****

C U(I,1)=U(I,2)-TDX*(1/(TDX*(I-1)+1))

C*****

C U(I,1)=U(I,2)-TDX*(1/(TDX*(I-1)))

C*****

C U(I,2)=1/(TDX*(I-1)+1)

U(I,1)=U(I,2)-TDX*COS(TDX*(I-1))*0.0174

C U(I,1)=U(I,2)+TDX*(EXP(-TDX*(I-1)-C))

C U(I,1)=U(I,2)+TDX*(EXP(-TDX*I-C))

C*****

C U(I,1)=U(I,2)-TDX*(1/(TDX*(I-1)+1))

C*****

C U(I,2)=0

C U(I,1)=U(I,2)-TDX*1

C GD(I,1)=(U(I,2)-U(I,1))/TDX

C*****

UI(I,2)=U(I,2)

UI(I,1)=U(I,1)

GD(I,2)=U(I,2)

GD(I,1)=U(I,1)

H(I,2)=0

H(I,1)=0

29 CONTINUE

C*****

C SAYISAL COZUM

C*****

K=2

L=N-1

DO 70 J=2,M-1

DO 75 I=K,L

UI(I,J+1)=(2*U(I,J)-U(I,J-1))+(C*D)*

*(U(I+1,J)-2*U(I,J)+U(I-1,J))

U(I,J+1)=UI(I,J+1)

C*****

C ANALITIK COZUM

C*****

C GD(I,J+1)=0.5*(EXP(-TDX*(I-1)-C*TDTO*(J-1))*1.36+

C *EXP(-TDX*(I-1)+C*TDTO*(J-1))*0.63)

C*****

C GD(I,J+1)=0.5*(EXP(-TDX*(I-1)-C*TDTO*(J-1))

C *+EXP(-TDX*(I-1)+C*TDTO*(J-1)))+(1/2*C)*

C *(ALOG(TDX*(I-1)+C*TDTO*(J-1)+1)-ALOG(TDX*(I-1)-C*TDTO*(J-1)+1))

C*****

C GD(I,J+1)=0.5*(SIN(TDX*(I-1)+C*TDTO*(J-1))*0.0174

C *+SIN(TDX*(I-1)-C*TDTO*(J-1))*0.0174)

C *+0.184*(EXP(-TDX*(I-1)-C*TDTO*(J-1))-EXP(-TDX*(I-1)+C*TDTO*(J-1)))

C*****

C GD(I,J+1)=0.5*(SIN(TDX*(I-1)+C*TDTO*(J-1))*0.0174

C *+SIN(TDX*(I-1)-C*TDTO*(J-1))*0.0174)+(1/2*C)*

C *(ALOG(TDX*(I-1)+C*TDTO*(J-1)+1)-ALOG(TDX*(I-1)-C*TDTO*(J-1)+1))

C*****

C GD(I,J+1)=0.5*((1/(TDX*I+C*TDTO*J))

C *+(1/(TDX*I-C*TDTO*J)))+(1/2*C*EXP(C))*

C *(EXP(-TDX*I-C*TDTO*J)-EXP(-TDX*I+C*TDTO*J))

C*****

C GD(I,J+1)=0.5*((1/(TDX*(I-1)+C*TDTO*(J-1)+1))

C *+(1/(TDX*(I-1)-C*TDTO*(J-1)+1)))+(1/2*C)*

C *(ALOG(TDX*(I-1)+C*TDTO*(J-1)+1)-ALOG(TDX*(I-1)-C*TDTO*(J-1)+1))

C*****

C GD(I,J+1)=0.5*((1/(TDX*(I-1)+C*TDTO*(J-1)))

C *+(1/(TDX*(I-1)-C*TDTO*(J-1))))

C *+(1/2*C)*(SIN(TDX*(I-1)+C*TDTO*(J-1))*0.0174-

C *SIN(TDX*(I-1)-C*TDTO*(J-1))*0.0174)

C*****

```

GD(I,J+1)=0.5*(EXP(-TDX*(I-1)-C*TDTO*(J-1))
*EXP(-TDX*(I-1)+C*TDTO*(J-1)))
*+0.5*(SIN(TDX*(I-1)+C*TDTO*(J-1))*0.0174-
*SIN(TDX*(I-1)-C*TDTO*(J-1))*0.0174)

```

```

C*****

```

```

C  GD(I,J+1)=0.5*(SIN(TDX*(I-1)+C*TDTO*(J-1))*0.0174
C  *+SIN(TDX*(I-1)-C*TDTO*(J-1))
C  **0.0174)+0.5*(SIN(TDX*(I-1)+C*TDTO*(J-1))*0.0174
C  *-SIN(TDX*(I-1)-C*TDTO*(J-1))*0.0174)

```

```

C*****

```

```

C  GD(I,J+1)=TDTO*(J-1)

```

```

C*****

```

```

C      IZAFI HATA

```

```

C*****

```

```

27  H(I,J+1)=(GD(I,J+1)-UI(I,J+1))/GD(I,J+1)

```

```

75  CONTINUE

```

```

    K=K+1

```

```

    L=L-1

```

```

70  CONTINUE

```

```

C*****

```

```

C      BASINC HESABI

```

```

C*****

```

```

    K=3

```

```

    L=N-2

```

```

    DO 76 J=3,M

```

```

    DO 77 I=K,L

```

```

    P(K-1,J)=P0

```

```

    P(L+1,J)=P0

```

```

    P(I,J)=(-RO0*TDX/TDTO)*(UI(I,J)-UI(I,J-1))+F*TDX

```

```

77  CONTINUE

```

```

    K=K+1

```

```

    L=L-1

```

```

76  CONTINUE

```

```

C*****

```

```

C      YOGUNLUK

```

```

C*****

```

```

    K=3

```

L=N-2

DO 78 J=2,M

DO 79 I=K,L

RO(K-1,J+1)=RO0

RO(L+1,J+1)=RO0

RO(I,J+1)=((P(I,J+1)-2*P(I,J)+P(I,J-1))/C*C)+2*RO(I,J)-RO(I,J-1)

79 CONTINUE

K=K+1

L=L-1

78 CONTINUE

C*****

C SONUCLARIN YAZDIRILMASI

C*****

K1=1

K2=11

151 IF(K2.GE.N) K2=N

WRITE(1,152) (I,I=K1,K2)

152 FORMAT(/,2X,'0',2X,11(I3,2X))

DO 34 J=0,M-1

WRITE(1,35) J,(UI(I,J+1),I=K1,K2)

35 FORMAT(1X,I3,1X,11(F5.2,1X))

34 CONTINUE

C IF(K2.LT.N) THEN

C K1=K1+15

C K2=K2+15

C GOTO 151

C ENDIF

K1=1

K2=11

36 IF(K2.GE.N) K2=N

WRITE(1,152) (I,I=K1,K2)

DO 37 J=0,M-1

WRITE(1,35) J,(GD(I,J+1),I=K1,K2)

37 CONTINUE

```

C  IF(K2.LT.M) THEN
C  K1=K1+15
C  K2=K2+15
C  GOTO 36
C  ENDIF
C  GOTO 48
      K1=1
      K2=11
38  IF(K2.GE.N) K2=N
      WRITE(1,152) (I,I=K1,K2)
      DO 39 J=0,M-1
          WRITE(1,35) J,(H(I,J+1),I=K1,K2)
39  CONTINUE
C  IF(K2.LT.M) THEN
C  K1=K1+15
C  K2=K2+15
C  GOTO 38
C  ENDIF
      K1=1
      K2=11
      IF(K2.GE.N) K2=N
      WRITE(1,152) (I,I=K1,K2)
      DO 80 J=1,M
          WRITE(1,35) J,(P(I,J),I=K1,K2)
80  CONTINUE
C  K1=1
C  K2=11
C  IF(K2.GE.N) K2=N
C  WRITE(1,152) (I,I=K1,K2)
C  DO 81 J=0,M-1
C  WRITE(1,35) J,(RO(I,J+1),I=K1,K2)
C 81 CONTINUE
      STOP
      END

```

C-2

D=25.0000000 TDX= 0.20

 $f(x)=c^x$, $g(x)=c^{x-0}$

TDTO= 1.00 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90

Sayısal Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	1.07	0.88	0.72	0.59	0.48	0.39	0.32	0.26	0.22	0.18	0.15
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	1.58	1.29	1.06	0.87	0.71	0.58	0.48	0.39	0.32	????
3	????	????	3.21	2.63	2.15	1.76	1.44	1.18	0.97	????	????
4	????	????	????	6.84	5.61	4.58	3.76	3.07	????	????	????
5	????	????	????	????	14.28	12.60	9.18	????	????	????	????
6	????	????	????	????	????	*****	????	????	????	????	????

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	1.07	0.88	0.72	0.59	0.48	0.39	0.32	0.26	0.22	0.18	0.15
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	0.91	0.74	0.61	0.50	0.41	0.33	0.27	0.22	0.18	????
3	????	????	1.62	1.33	1.09	0.89	0.73	0.60	0.49	????	????
4	????	????	????	3.49	2.86	2.34	1.92	1.57	????	????	????
5	????	????	????	????	7.73	6.33	5.18	????	????	????	????
6	????	????	????	????	????	17.20	????	????	????	????	????

İzafi Hatalar

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	????
3	????	????	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98	????	????
4	????	????	????	-0.96	-0.96	-0.96	-0.96	-0.96	????	????	????
5	????	????	????	????	-0.85	-0.99	-0.77	????	????	????	????
6	????	????	????	????	????	2.33	????	????	????	????	????

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.09	-0.07	-0.06	-0.04	-0.03	-0.02	-0.01	0.90	????
4	????	????	0.90	-0.26	-0.21	-0.17	-0.14	-0.11	0.90	????	????
5	????	????	????	0.90	-0.60	-0.49	-0.40	0.90	????	????	????
6	????	????	????	????	0.90	-1.42	0.90	????	????	????	????

D= 1.0000000 TDX= 0.50

TDTO= 0.50 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.18	0.72	0.44	0.26	0.16	0.10	0.06	0.04	0.02	0.01	0.01
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.65	0.39	0.24	0.14	0.09	0.05	0.03	0.02	0.01	?????
3	?????	?????	0.52	0.32	0.19	0.12	0.07	0.04	0.03	?????	?????
4	?????	?????	?????	0.47	0.29	0.17	0.11	0.06	?????	?????	?????
5	?????	?????	?????	?????	0.46	0.28	0.17	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.45	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.18	0.72	0.44	0.26	0.16	0.10	0.06	0.04	0.02	0.01	0.01
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.62	0.37	0.21	0.13	0.08	0.05	0.03	0.02	0.01	?????
3	?????	?????	0.50	0.31	0.16	0.09	0.06	0.03	0.02	?????	?????
4	?????	?????	?????	0.45	0.28	0.15	0.10	0.05	?????	?????	?????
5	?????	?????	?????	?????	0.44	0.27	0.17	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.43	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.05	-0.05	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	?????
3	?????	?????	-0.04	-0.10	-0.28	-0.28	-0.28	-0.28	-0.28	?????	?????
4	?????	?????	?????	-0.04	-0.04	-0.13	-0.10	-0.36	?????	?????	?????
5	?????	?????	?????	?????	-0.05	-0.04	0.00	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.05	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.90	?????
4	?????	?????	0.90	-0.02	0.01	0.02	0.03	0.04	0.90	?????	?????
5	?????	?????	?????	0.90	-0.04	0.00	0.02	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.04	0.90	?????	?????	?????	?????

D=4.0000000 TDX= 0.50

TDTO= 1.00 C= 1.00

F= 0.10 ROO= 0.90

P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.18	0.72	0.44	0.26	0.16	0.10	0.06	0.04	0.02	0.01	0.01
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	1.11	0.68	0.41	0.25	0.15	0.09	0.06	0.03	0.02	?????
3	?????	?????	1.67	1.02	0.62	0.37	0.23	0.14	0.08	?????	?????
4	?????	?????	?????	2.66	1.61	0.98	0.59	0.36	?????	?????	?????
5	?????	?????	?????	?????	4.25	2.58	1.56	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	6.81	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.18	0.72	0.44	0.26	0.16	0.10	0.06	0.04	0.02	0.01	0.01
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.67	0.41	0.25	0.15	0.09	0.06	0.03	0.02	0.01	?????
3	?????	?????	0.89	0.54	0.33	0.20	0.12	0.07	0.04	?????	?????
4	?????	?????	?????	1.42	0.86	0.52	0.32	0.19	?????	?????	?????
5	?????	?????	?????	?????	2.33	1.41	0.86	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	3.84	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.66	-0.66	-0.66	-0.66	-0.66	-0.66	-0.66	-0.66	-0.66	?????
3	?????	?????	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	?????	?????
4	?????	?????	?????	-0.87	-0.87	-0.87	-0.87	-0.87	?????	?????	?????
5	?????	?????	?????	?????	-0.83	-0.83	-0.83	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.78	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.09	-0.03	0.00	0.02	0.03	0.04	0.04	0.90	?????
4	?????	?????	0.90	-0.22	-0.12	-0.05	-0.01	0.01	0.90	?????	?????
5	?????	?????	?????	0.90	-0.40	-0.22	-0.11	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.67	0.90	?????	?????	?????	?????

D=0.2500000 TDX= 1.00

TDTO= 0.50 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.37	0.50	0.19	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	????	0.33	0.12	0.04	0.02	0.01	0.00	0.00	0.00	0.00	????
3	????	????	0.14	0.05	0.02	0.01	0.00	0.00	0.00	????	????
4	????	????	????	0.07	0.03	0.01	0.00	0.00	????	????	????
5	????	????	????	????	0.04	0.02	0.01	????	????	????	????
6	????	????	????	????	????	0.03	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.37	0.50	0.19	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	????	0.34	0.13	0.05	0.02	0.01	0.00	0.00	0.00	0.00	????
3	????	????	0.15	0.06	0.02	0.01	0.00	0.00	0.00	????	????
4	????	????	????	0.08	0.03	0.01	0.00	0.00	????	????	????
5	????	????	????	????	0.04	0.02	0.01	????	????	????	????
6	????	????	????	????	????	0.03	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	????
3	????	????	0.05	0.05	0.05	0.05	0.05	0.05	0.05	????	????
4	????	????	????	0.05	0.05	0.05	0.05	0.05	????	????	????
5	????	????	????	????	0.04	0.04	0.04	????	????	????	????
6	????	????	????	????	????	0.02	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.12	0.11	0.10	0.10	0.10	0.10	0.10	0.90	????
4	????	????	0.90	0.09	0.10	0.10	0.10	0.10	0.90	????	????
5	????	????	????	0.90	0.09	0.09	0.10	0.90	????	????	????
6	????	????	????	????	0.90	0.09	0.90	????	????	????	????

D=1.0000000 TDX= 0.20

TDTO= 0.20 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.07	0.88	0.72	0.59	0.48	0.39	0.32	0.26	0.22	0.18	0.15
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	?????	0.79	0.65	0.53	0.43	0.36	0.29	0.24	0.20	0.16	?????
3	?????	?????	0.65	0.53	0.44	0.36	0.29	0.24	0.20	?????	?????
4	?????	?????	?????	0.56	0.46	0.37	0.31	0.25	?????	?????	?????
5	?????	?????	?????	?????	0.49	0.41	0.33	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.45	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.07	0.88	0.72	0.59	0.48	0.39	0.32	0.26	0.22	0.18	0.15
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	?????	0.78	0.65	0.52	0.42	0.35	0.28	0.23	0.19	0.16	?????
3	?????	?????	0.64	0.52	0.43	0.34	0.28	0.23	0.19	?????	?????
4	?????	?????	?????	0.55	0.46	0.35	0.29	0.23	?????	?????	?????
5	?????	?????	?????	?????	0.48	0.40	0.32	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.44	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.01	0.00	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	?????
3	?????	?????	-0.01	-0.01	-0.03	-0.05	-0.05	-0.05	-0.05	?????	?????
4	?????	?????	?????	-0.02	0.00	-0.07	-0.07	-0.07	?????	?????	?????
5	?????	?????	?????	?????	-0.02	-0.03	-0.03	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.90	?????
4	?????	?????	0.90	0.02	0.02	0.02	0.02	0.02	0.90	?????	?????
5	?????	?????	?????	0.90	0.00	0.01	0.01	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.01	0.90	?????	?????	?????	?????

D=0.1600000 TDX= 0.50

TDTO= 0.20 C= 1.00

F= 0.10 ROO= 0.90

P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.18	0.72	0.44	0.26	0.16	0.10	0.06	0.04	0.02	0.01	0.01
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.52	0.32	0.19	0.12	0.07	0.04	0.03	0.02	0.01	?????
3	?????	?????	0.28	0.17	0.10	0.06	0.04	0.02	0.01	?????	?????
4	?????	?????	?????	0.15	0.09	0.06	0.03	0.02	?????	?????	?????
5	?????	?????	?????	?????	0.08	0.05	0.03	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.05	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.18	0.72	0.44	0.26	0.16	0.10	0.06	0.04	0.02	0.01	0.01
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.51	0.33	0.21	0.13	0.08	0.05	0.03	0.02	0.01	?????
3	?????	?????	0.28	0.16	0.10	0.08	0.05	0.03	0.02	?????	?????
4	?????	?????	?????	0.14	0.08	0.08	0.05	0.03	?????	?????	?????
5	?????	?????	?????	?????	0.07	0.06	0.04	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.05	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.02	0.03	0.09	0.09	0.09	0.09	0.09	0.09	0.09	?????
3	?????	?????	0.00	-0.06	0.10	0.19	0.19	0.19	0.19	?????	?????
4	?????	?????	?????	-0.07	-0.13	0.29	0.29	0.29	?????	?????	?????
5	?????	?????	?????	?????	-0.14	0.17	0.25	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.00	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.17	0.12	0.09	0.08	0.07	0.06	0.06	0.90	?????
4	?????	?????	0.90	0.10	0.08	0.07	0.06	0.06	0.90	?????	?????
5	?????	?????	?????	0.90	0.07	0.06	0.06	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.06	0.90	?????	?????	?????	?????

D=6.2500000 **TDX= 0.20**
TDTO= 0.50 **C= 1.00**
F= 0.10 **RCO= 0.90**
P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.07	0.88	0.72	0.59	0.48	0.39	0.32	0.26	0.22	0.18	0.15
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	0.96	0.79	0.65	0.53	0.43	0.35	0.29	0.24	0.19	????
3	????	????	1.11	0.91	0.74	0.61	0.50	0.41	0.33	????	????
4	????	????	????	1.39	1.14	0.93	0.76	0.63	????	????	????
5	????	????	????	????	1.82	1.49	1.22	????	????	????	????
6	????	????	????	????	????	2.39	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.07	0.88	0.72	0.59	0.48	0.39	0.32	0.26	0.22	0.18	0.15
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	0.76	0.62	0.51	0.42	0.34	0.28	0.23	0.19	0.15	????
3	????	????	0.74	0.61	0.50	0.41	0.33	0.27	0.22	????	????
4	????	????	????	0.86	0.70	0.58	0.47	0.39	????	????	????
5	????	????	????	????	1.09	0.89	0.73	????	????	????	????
6	????	????	????	????	????	1.43	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26	????
3	????	????	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	-0.49	????	????
4	????	????	????	-0.62	-0.62	-0.62	-0.62	-0.62	????	????	????
5	????	????	????	????	-0.68	-0.68	-0.67	????	????	????	????
6	????	????	????	????	????	-0.67	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.01	0.90	????
4	????	????	0.90	-0.07	-0.06	-0.04	-0.03	-0.02	0.90	????	????
5	????	????	????	0.90	-0.12	-0.10	-0.08	0.90	????	????	????
6	????	????	????	????	0.90	-0.18	0.90	????	????	????	????

D=1.0000000 TDX= 0.20

TDTO= 0.20 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90 $f(x)=e^{-x}$, $g(x)=\frac{1}{x+1}$ **Sayısal Çözüm**

0	1	2	3	4	5	6	7	8	9	10	11
0	0.80	0.65	0.53	0.42	0.34	0.27	0.21	0.16	0.12	0.09	0.07
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	1.02	0.84	0.70	0.58	0.48	0.40	0.34	0.29	0.24	????
3	????	????	1.04	0.87	0.73	0.61	0.52	0.44	0.38	????	????
4	????	????	????	1.08	0.91	0.77	0.66	0.56	????	????	????
5	????	????	????	????	1.12	0.95	0.81	????	????	????	????
6	????	????	????	????	????	1.16	????	????	????	????	????

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.80	0.65	0.53	0.42	0.34	0.27	0.21	0.16	0.12	0.09	0.07
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	1.03	0.82	0.68	0.56	0.48	0.40	0.34	0.29	0.24	????
3	????	????	1.02	0.85	0.72	0.60	0.51	0.44	0.38	????	????
4	????	????	????	1.04	0.90	0.75	0.65	0.56	????	????	????
5	????	????	????	????	1.10	0.93	0.80	????	????	????	????
6	????	????	????	????	????	1.16	????	????	????	????	????

İzafi Hata

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.01	-0.02	-0.03	-0.04	0.00	0.00	0.00	0.00	0.00	????
3	????	????	-0.02	-0.02	-0.01	-0.02	-0.02	0.00	0.00	????	????
4	????	????	????	-0.04	-0.01	-0.03	-0.01	0.00	????	????	????
5	????	????	????	????	-0.02	-0.02	-0.01	????	????	????	????
6	????	????	????	????	????	0.00	????	????	????	????	????

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.13	-0.11	-0.10	-0.08	-0.07	-0.06	-0.06	0.90	????
4	????	????	0.90	-0.14	-0.12	-0.10	-0.09	-0.07	0.90	????	????
5	????	????	????	0.90	-0.14	-0.12	-0.10	0.90	????	????	????
6	????	????	????	????	0.90	-0.14	0.90	????	????	????	????

D=0.1600000 TDX= 0.50

TDTO= 0.20 C= 1.00

F= 0.10 ROO= 0.90 P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.27	0.12	0.02	-0.03	-0.06	-0.08	-0.08	-0.08	-0.08	-0.08
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	????	0.96	0.63	0.43	0.31	0.23	0.18	0.14	0.12	0.10	????
3	????	????	0.92	0.65	0.49	0.38	0.31	0.26	0.22	????	????
4	????	????	????	0.89	0.68	0.54	0.44	0.37	????	????	????
5	????	????	????	????	0.88	0.70	0.58	????	????	????	????
6	????	????	????	????	????	0.87	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.27	0.12	0.02	-0.03	-0.06	-0.08	-0.08	-0.08	-0.08	-0.08
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	????	0.95	0.61	0.41	0.31	0.23	0.18	0.14	0.12	0.10	????
3	????	????	0.90	0.62	0.47	0.38	0.31	0.26	0.22	????	????
4	????	????	????	0.87	0.66	0.54	0.44	0.37	????	????	????
5	????	????	????	????	0.87	0.69	0.58	????	????	????	????
6	????	????	????	????	????	0.87	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.01	-0.02	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	????
3	????	????	-0.02	-0.05	-0.04	0.00	0.00	0.00	0.00	????	????
4	????	????	????	-0.02	-0.03	0.00	0.00	0.00	????	????	????
5	????	????	????	????	-0.01	-0.01	0.00	????	????	????	????
6	????	????	????	????	????	0.00	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.55	-0.42	-0.34	-0.28	-0.24	-0.20	-0.18	0.90	????
4	????	????	0.90	-0.45	-0.35	-0.29	-0.24	-0.21	0.90	????	????
5	????	????	????	0.90	-0.37	-0.30	-0.25	0.90	????	????	????
6	????	????	????	????	0.90	-0.32	0.90	????	????	????	????

D=1.0000000 TDX= 0.50
 TDTO= 0.50 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.27	0.12	0.02	-0.03	-0.06	-0.08	-0.08	-0.08	-0.08	-0.08
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	1.09	0.71	0.48	0.34	0.25	0.19	0.15	0.12	0.10	?????
3	?????	?????	1.21	0.83	0.59	0.44	0.35	0.28	0.24	?????	?????
4	?????	?????	?????	1.32	0.93	0.69	0.53	0.43	?????	?????	?????
5	?????	?????	?????	?????	1.42	1.02	0.78	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	1.50	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.27	0.12	0.02	-0.03	-0.06	-0.08	-0.08	-0.08	-0.08	-0.08
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	1.07	0.69	0.46	0.32	0.24	0.18	0.15	0.12	0.10	?????
3	?????	?????	1.19	0.81	0.56	0.43	0.34	0.28	0.24	?????	?????
4	?????	?????	?????	1.30	0.92	0.69	0.53	0.43	?????	?????	?????
5	?????	?????	?????	?????	1.40	1.02	0.78	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	1.50	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.02	-0.03	-0.04	-0.05	-0.04	-0.06	0.00	0.00	0.00	?????
3	?????	?????	-0.02	-0.02	-0.04	-0.02	-0.03	0.00	0.00	?????	?????
4	?????	?????	?????	-0.02	-0.01	0.00	0.00	0.00	?????	?????	?????
5	?????	?????	?????	?????	-0.01	0.00	0.00	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.00	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.26	-0.18	-0.13	-0.10	-0.07	-0.06	-0.04	0.90	?????
4	?????	?????	0.90	-0.26	-0.18	-0.13	-0.09	-0.07	0.90	?????	?????
5	?????	?????	?????	0.90	-0.26	-0.17	-0.12	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.25	0.90	?????	?????	?????	?????

D=0.2500000 **TDX= 1.00**
TDTO= 0.50 **C= 1.00**
F= 0.10 **ROO= 0.90** **PO= 0.90**

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	-0.13	-0.20	-0.20	-0.18	-0.16	-0.14	-0.12	-0.11	-0.10	-0.09
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	77777	0.97	0.51	0.31	0.22	0.18	0.15	0.13	0.11	0.10	77777
3	77777	77777	0.94	0.60	0.44	0.35	0.29	0.25	0.22	77777	77777
4	77777	77777	77777	0.94	0.67	0.53	0.44	0.38	77777	77777	77777
5	77777	77777	77777	77777	0.94	0.73	0.60	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	0.94	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	-0.13	-0.20	-0.20	-0.18	-0.16	-0.14	-0.12	-0.11	-0.10	-0.09
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	77777	0.95	0.50	0.31	0.22	0.18	0.14	0.13	0.11	0.10	77777
3	77777	77777	0.92	0.60	0.44	0.35	0.28	0.25	0.22	77777	77777
4	77777	77777	77777	0.94	0.65	0.53	0.44	0.38	77777	77777	77777
5	77777	77777	77777	77777	0.94	0.73	0.60	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	0.94	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	77777	-0.02	-0.02	0.00	0.00	0.00	-0.07	0.00	0.00	0.00	77777
3	77777	77777	-0.02	0.00	0.00	0.00	-0.03	0.00	0.00	77777	77777
4	77777	77777	77777	0.00	-0.03	0.00	0.00	0.00	77777	77777	77777
5	77777	77777	77777	77777	0.00	0.00	0.00	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	0.00	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	77777	0.90	-0.57	-0.37	-0.27	-0.20	-0.16	-0.13	-0.10	0.90	77777
4	77777	77777	0.90	-0.42	-0.29	-0.21	-0.16	-0.13	0.90	77777	77777
5	77777	77777	77777	0.90	-0.32	-0.23	-0.17	0.90	77777	77777	77777
6	77777	77777	77777	77777	0.90	-0.25	0.90	77777	77777	77777	77777

D=0.04 TDX= 1.00
 TDTO= 0.20 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	-0.13	-0.20	-0.20	-0.18	-0.16	-0.14	-0.12	-0.11	-0.10	-0.09
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	77777	0.88	0.47	0.30	0.22	0.17	0.15	0.13	0.11	0.10	77777
3	77777	77777	0.82	0.56	0.42	0.34	0.29	0.25	0.22	77777	77777
4	77777	77777	77777	0.82	0.63	0.51	0.43	0.38	77777	77777	77777
5	77777	77777	77777	77777	0.83	0.68	0.58	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	0.85	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	-0.13	-0.20	-0.20	-0.18	-0.16	-0.14	-0.12	-0.11	-0.10	-0.09
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	77777	0.86	0.44	0.27	0.21	0.17	0.15	0.13	0.11	0.10	77777
3	77777	77777	0.80	0.55	0.40	0.33	0.29	0.25	0.22	77777	77777
4	77777	77777	77777	0.80	0.62	0.50	0.43	0.38	77777	77777	77777
5	77777	77777	77777	77777	0.81	0.67	0.57	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	0.84	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	77777	-0.02	-0.07	-0.10	-0.05	0.00	0.00	0.00	0.00	0.00	77777
3	77777	77777	-0.03	-0.02	-0.05	-0.03	0.00	0.00	0.00	77777	77777
4	77777	77777	77777	-0.03	-0.02	-0.02	0.00	0.00	77777	77777	77777
5	77777	77777	77777	77777	-0.02	-0.01	-0.02	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	-0.01	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	77777	0.90	-1.43	-1.03	-0.80	-0.65	-0.54	-0.46	-0.40	0.90	77777
4	77777	77777	0.90	-1.05	-0.81	-0.65	-0.54	-0.46	0.90	77777	77777
5	77777	77777	77777	0.90	-0.82	-0.66	-0.55	0.90	77777	77777	77777
6	77777	77777	77777	77777	0.90	-0.67	0.90	77777	77777	77777	77777

D=4.0000000 TDX= 0.50
 TDTO= 1.00 C= 1.00
 F= 0.10 ROO= 0.90 P0= 0.90 $f(x)=e^{-x}$, $g(x)=\cos(x)$

Sayısal Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	????	1.23	0.75	0.45	0.27	0.16	0.09	0.05	0.03	0.02	????
3	????	????	1.88	1.14	0.69	0.41	0.25	0.15	0.09	????	????
4	????	????	????	2.99	1.81	1.10	0.67	0.40	????	????	????
5	????	????	????	????	4.79	2.91	1.77	????	????	????	????
6	????	????	????	????	????	7.68	????	????	????	????	????

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	????	0.95	0.58	0.35	0.20	0.11	0.06	0.03	0.02	0.01	????
3	????	????	1.39	0.84	0.50	0.30	0.17	0.10	0.06	????	????
4	????	????	????	2.25	1.36	0.82	0.50	0.30	????	????	????
5	????	????	????	????	3.70	2.25	1.37	????	????	????	????
6	????	????	????	????	????	6.10	????	????	????	????	????

İzafi Hata

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.30	-0.30	-0.31	-0.33	-0.38	-0.48	-0.61	-0.68	-0.47	????
3	????	????	-0.35	-0.36	-0.37	-0.39	-0.43	-0.48	-0.50	????	????
4	????	????	????	-0.33	-0.33	-0.33	-0.34	-0.34	????	????	????
5	????	????	????	????	-0.29	-0.29	-0.29	????	????	????	????
6	????	????	????	????	????	-0.26	????	????	????	????	????

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.12	-0.05	-0.01	0.02	0.03	0.04	0.04	0.90	????
4	????	????	0.90	-0.26	-0.14	-0.06	-0.02	0.01	0.90	????	????
5	????	????	????	0.90	-0.46	-0.26	-0.14	0.90	????	????	????
6	????	????	????	????	0.90	-0.77	0.90	????	????	????	????

D=0.0400000 TDX= 1.00
 TDTO= 0.20 C= 1.00
 F= 0.10 ROO= 0.90 P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.36	0.14	0.07	0.03	0.00	-0.01	-0.01	0.00	0.02	0.01
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	?????	0.39	0.13	0.03	0.01	0.01	0.02	0.01	0.00	-0.02	?????
3	?????	?????	0.14	0.02	0.00	0.02	0.04	0.03	0.00	?????	?????
4	?????	?????	?????	0.01	-0.01	0.02	0.05	0.04	?????	?????	?????
5	?????	?????	?????	?????	-0.01	0.03	0.06	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.03	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.36	0.14	0.07	0.03	0.00	-0.01	-0.01	0.00	0.02	0.01
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	?????	0.38	0.14	0.04	0.02	0.01	0.01	0.00	0.00	0.00	?????
3	?????	?????	0.14	0.03	0.02	0.01	0.01	0.01	0.00	?????	?????
4	?????	?????	?????	0.02	0.02	0.01	0.01	0.33	?????	?????	?????
5	?????	?????	?????	?????	0.02	0.02	0.05	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.04	0.02	0.25	0.53	-0.52	-2.30	-2.98	*****	-4.20	?????
3	?????	?????	0.03	0.33	1.10	-0.88	-2.88	-3.40	-6.37	?????	?????
4	?????	?????	?????	0.50	1.60	-1.10	-3.11	-3.55	?????	?????	?????
5	?????	?????	?????	?????	1.89	0.50	0.02	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.50	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.11	0.17	0.15	0.08	0.02	0.04	0.11	0.90	?????
4	?????	?????	0.90	0.15	0.14	0.08	0.03	0.04	0.90	?????	?????
5	?????	?????	?????	0.90	0.13	0.08	0.03	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.08	0.90	?????	?????	?????	?????

$D=0.2500000$ $TDX=1.00$
 $TDTO=0.50$ $C=1.00$
 $F=0.10$ $ROO=0.90$ $P0=0.90$

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.36	0.14	0.07	0.03	0.00	-0.01	-0.01	0.00	0.02	0.01
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	????	0.48	0.16	0.05	0.01	0.01	0.02	0.01	0.00	-0.02	????
3	????	????	0.24	0.06	0.01	0.02	0.03	0.02	0.00	????	????
4	????	????	????	0.11	0.03	0.03	0.04	0.03	????	????	????
5	????	????	????	????	0.07	0.04	0.05	????	????	????	????
6	????	????	????	????	????	0.06	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.36	0.14	0.07	0.03	0.00	-0.01	-0.01	0.00	0.02	0.01
1	1.00	0.37	0.14	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
2	????	0.47	0.15	0.05	0.02	0.01	0.01	0.01	0.00	-0.01	????
3	????	????	0.24	0.06	0.02	0.01	0.02	0.01	0.00	????	????
4	????	????	????	0.10	0.03	0.02	0.03	0.02	????	????	????
5	????	????	????	????	0.06	0.03	0.05	????	????	????	????
6	????	????	????	????	????	0.05	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.02	-0.11	0.04	0.22	-0.36	-0.84	-0.95	-1.52	-1.10	????
3	????	????	0.00	-0.02	0.23	-0.47	-0.92	-1.00	-1.39	????	????
4	????	????	????	-0.14	0.02	-0.49	-0.30	-1.02	????	????	????
5	????	????	????	????	-0.16	-0.45	0.00	????	????	????	????
6	????	????	????	????	????	-0.20	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.05	0.11	0.11	0.09	0.07	0.08	0.10	0.90	????
4	????	????	0.90	0.07	0.10	0.09	0.07	0.08	0.90	????	????
5	????	????	????	0.90	0.07	0.08	0.08	0.90	????	????	????
6	????	????	????	????	0.90	0.08	0.90	????	????	????	????

D=25.0000000 TDX= 0.20
 TDTO= 1.00 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	?????	1.64	1.35	1.10	0.90	0.74	0.60	0.49	0.40	0.33	?????
3	?????	?????	3.37	2.76	2.26	1.85	1.51	1.24	1.01	?????	?????
4	?????	?????	?????	7.17	5.87	4.80	3.94	3.22	?????	?????	?????
5	?????	?????	?????	?????	14.96	13.17	9.65	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	*****	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	?????	1.28	1.05	0.86	0.70	0.58	0.47	0.38	0.31	0.25	?????
3	?????	?????	2.54	2.08	1.70	1.39	1.14	0.93	0.76	?????	?????
4	?????	?????	?????	5.53	4.53	3.71	3.03	2.48	?????	?????	?????
5	?????	?????	?????	?????	12.26	10.04	8.22	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	27.29	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.29	-0.28	-0.28	-0.28	-0.28	-0.29	-0.29	-0.30	-0.31	?????
3	?????	?????	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	?????	?????
4	?????	?????	?????	-0.30	-0.30	-0.30	-0.30	-0.29	?????	?????	?????
5	?????	?????	?????	?????	-0.22	-0.31	-0.17	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	1.79	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.10	-0.08	-0.06	-0.05	-0.03	-0.02	-0.02	0.90	?????
4	?????	?????	0.90	-0.28	-0.22	-0.18	-0.14	-0.11	0.90	?????	?????
5	?????	?????	?????	0.90	-0.63	-0.51	-0.42	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-1.49	0.90	?????	?????	?????	?????

D=6.2500000 TDX= 0.20
 TDTO= 0.50 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	?????	1.03	0.84	0.69	0.56	0.46	0.38	0.31	0.25	0.21	?????
3	?????	?????	1.22	1.00	0.82	0.67	0.55	0.45	0.37	?????	?????
4	?????	?????	?????	1.56	1.28	1.05	0.86	0.70	?????	?????	?????
5	?????	?????	?????	?????	2.06	1.69	1.38	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	2.70	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	?????	0.93	0.76	0.63	0.51	0.42	0.34	0.28	0.23	0.18	?????
3	?????	?????	1.05	0.86	0.70	0.58	0.47	0.38	0.31	?????	?????
4	?????	?????	?????	1.31	1.07	0.87	0.71	0.58	?????	?????	?????
5	?????	?????	?????	?????	1.70	1.39	1.14	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	2.26	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11	-0.12	?????
3	?????	?????	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.18	?????	?????
4	?????	?????	?????	-0.20	-0.20	-0.20	-0.20	-0.20	?????	?????	?????
5	?????	?????	?????	?????	-0.21	-0.21	-0.21	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.19	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.90	?????
4	?????	?????	0.90	-0.09	-0.07	-0.06	-0.04	-0.03	0.90	?????	?????
5	?????	?????	?????	0.90	-0.15	-0.12	-0.09	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.21	0.90	?????	?????	?????	?????

D=1.0000000 **TDX= 0.50**
TDTO= 0.50 **C= 1.00**
F= 0.10 **ROO= 0.90**
PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.77	0.47	0.28	0.17	0.10	0.05	0.03	0.02	0.01	?????
3	?????	?????	0.68	0.41	0.24	0.14	0.08	0.04	0.02	?????	?????
4	?????	?????	?????	0.64	0.38	0.22	0.13	0.07	?????	?????	?????
5	?????	?????	?????	?????	0.62	0.37	0.22	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.62	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.75	0.46	0.25	0.15	0.09	0.05	0.03	0.02	0.01	?????
3	?????	?????	0.66	0.39	0.22	0.13	0.06	0.03	0.02	?????	?????
4	?????	?????	?????	0.62	0.36	0.20	0.12	0.05	?????	?????	?????
5	?????	?????	?????	?????	0.60	0.35	0.20	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.60	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.03	-0.02	-0.11	-0.11	-0.12	-0.13	-0.13	-0.14	-0.12	?????
3	?????	?????	-0.03	-0.05	-0.09	-0.08	-0.22	-0.25	-0.26	?????	?????
4	?????	?????	?????	-0.03	-0.05	-0.10	-0.08	-0.27	?????	?????	?????
5	?????	?????	?????	?????	-0.03	-0.06	-0.10	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.03	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.04	0.00	0.02	0.04	0.05	0.05	0.05	0.90	?????
4	?????	?????	0.90	-0.07	-0.02	0.01	0.03	0.04	0.90	?????	?????
5	?????	?????	?????	0.90	-0.08	-0.03	0.01	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.08	0.90	?????	?????	?????	?????

D=0.1600000 TDX= 0.50
 TDTO= 0.20 C= 1.00
 F= 0.10 ROO= 0.90
 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.64	0.39	0.23	0.14	0.08	0.04	0.02	0.01	0.01	?????
3	?????	?????	0.42	0.25	0.15	0.08	0.04	0.02	0.01	?????	?????
4	?????	?????	?????	0.28	0.16	0.08	0.04	0.01	?????	?????	?????
5	?????	?????	?????	?????	0.18	0.09	0.04	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.11	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	?????	0.62	0.38	0.23	0.14	0.08	0.05	0.03	0.02	0.01	?????
3	?????	?????	0.40	0.24	0.14	0.08	0.05	0.03	0.02	?????	?????
4	?????	?????	?????	0.27	0.16	0.09	0.05	0.03	?????	?????	?????
5	?????	?????	?????	?????	0.18	0.10	0.05	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.11	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.03	-0.03	-0.02	0.00	0.03	0.09	0.16	0.19	0.08	?????
3	?????	?????	-0.05	-0.04	-0.01	0.06	0.17	0.32	0.39	?????	?????
4	?????	?????	?????	-0.06	-0.02	0.07	0.23	0.45	?????	?????	?????
5	?????	?????	?????	?????	-0.03	0.07	0.26	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.06	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.01	0.03	0.05	0.06	0.06	0.07	0.06	0.90	?????
4	?????	?????	0.90	0.01	0.03	0.05	0.06	0.06	0.90	?????	?????
5	?????	?????	?????	0.90	0.02	0.04	0.05	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.03	0.90	?????	?????	?????	?????

D=1.0000000 **TDX= 0.20**
TDTO= 0.20 **C= 1.00**
F= 0.10 **ROO= 0.90** **PO= 0.90**

0	1	2	3	4	5	6	7	8	9	10	11
0	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	0.85	0.70	0.57	0.47	0.38	0.31	0.26	0.21	0.17	????
3	????	????	0.76	0.62	0.51	0.42	0.34	0.28	0.23	????	????
4	????	????	????	0.69	0.57	0.46	0.38	0.31	????	????	????
5	????	????	????	????	0.65	0.53	0.43	????	????	????	????
6	????	????	????	????	????	0.62	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
1	1.00	0.82	0.67	0.55	0.45	0.37	0.30	0.25	0.20	0.17	0.14
2	????	0.84	0.69	0.56	0.46	0.38	0.31	0.25	0.21	0.17	????
3	????	????	0.75	0.60	0.49	0.40	0.33	0.27	0.22	????	????
4	????	????	????	0.68	0.56	0.44	0.36	0.29	????	????	????
5	????	????	????	????	0.64	0.50	0.41	????	????	????	????
6	????	????	????	????	????	0.61	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	????
3	????	????	-0.01	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	????	????
4	????	????	????	-0.01	-0.02	-0.05	-0.05	-0.05	????	????	????
5	????	????	????	????	-0.02	-0.07	-0.07	????	????	????	????
6	????	????	????	????	????	-0.02	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.90	????
4	????	????	0.90	-0.02	-0.02	-0.01	0.00	0.00	0.90	????	????
5	????	????	????	0.90	-0.03	-0.02	-0.02	0.90	????	????	????
6	????	????	????	????	0.90	-0.04	0.90	????	????	????	????

D=4.0000000 TDX= 0.50
 TDTO= 1.00 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	???	1.23	0.75	0.45	0.27	0.16	0.09	0.05	0.03	0.02	???
3	???	???	1.88	1.14	0.69	0.41	0.25	0.15	0.09	???	???
4	???	???	???	2.99	1.81	1.10	0.67	0.40	???	???	???
5	???	???	???	???	4.79	2.91	1.77	???	???	???	???
6	???	???	???	???	???	7.68	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
0	0.99	0.60	0.36	0.22	0.14	0.09	0.06	0.04	0.02	0.01	0.00
1	1.00	0.61	0.37	0.22	0.14	0.08	0.05	0.03	0.02	0.01	0.01
2	???	0.95	0.58	0.35	0.20	0.11	0.06	0.03	0.02	0.01	???
3	???	???	1.39	0.84	0.50	0.30	0.17	0.10	0.06	???	???
4	???	???	???	2.25	1.36	0.82	0.50	0.30	???	???	???
5	???	???	???	???	3.70	2.25	1.37	???	???	???	???
6	???	???	???	???	???	6.10	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	???	-0.30	-0.30	-0.31	-0.33	-0.38	-0.48	-0.61	-0.68	-0.47	???
3	???	???	-0.35	-0.36	-0.37	-0.39	-0.43	-0.48	-0.50	???	???
4	???	???	???	-0.33	-0.33	-0.33	-0.34	-0.34	???	???	???
5	???	???	???	???	-0.29	-0.29	-0.29	???	???	???	???
6	???	???	???	???	???	-0.26	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	???	0.90	-0.12	-0.05	-0.01	0.02	0.03	0.04	0.04	0.90	???
4	???	???	0.90	-0.26	-0.14	-0.06	-0.02	0.01	0.90	???	???
5	???	???	???	0.90	-0.46	-0.26	-0.14	0.90	???	???	???
6	???	???	???	???	0.90	-0.77	0.90	???	???	???	???

D=1.0000000 TDX= 0.20

TDTO= 0.20 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90 $f(x)=\sin(x)$, $g(x)=-e^{-x}$

Sayısal Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	-0.06	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.00	????
3	????	????	-0.09	-0.07	-0.06	-0.04	-0.03	-0.02	-0.01	????	????
4	????	????	????	-0.12	-0.09	-0.07	-0.06	-0.04	????	????	????
5	????	????	????	????	-0.14	-0.11	-0.09	????	????	????	????
6	????	????	????	????	????	-0.15	????	????	????	????	????

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	-0.06	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.00	????
3	????	????	-0.10	-0.07	-0.06	-0.04	-0.03	-0.02	-0.01	????	????
4	????	????	????	-0.12	-0.09	-0.07	-0.06	-0.04	????	????	????
5	????	????	????	????	-0.14	-0.11	-0.09	????	????	????	????
6	????	????	????	????	????	-0.15	????	????	????	????	????

İzafi Hata

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.01	0.00	0.00	0.00	-0.01	-0.03	-0.15	0.12	0.06	????
3	????	????	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03	????	????
4	????	????	????	0.00	0.00	0.00	-0.01	-0.01	????	????	????
5	????	????	????	????	0.00	0.00	-0.01	????	????	????	????
6	????	????	????	????	????	0.00	????	????	????	????	????

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.06	0.06	0.05	0.04	0.04	0.04	0.03	0.90	????
4	????	????	0.90	0.06	0.05	0.05	0.04	0.04	0.90	????	????
5	????	????	????	0.90	0.05	0.05	0.04	0.90	????	????	????
6	????	????	????	????	0.90	0.05	0.90	????	????	????	????

D=6.2500000 TDX= 0.20
 TDTO= 0.50 C= 1.00
 F= 0.10 ROO= 0.90
 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	-0.06	-0.04	-0.03	-0.02	-0.02	-0.01	-0.01	0.00	0.00	????
3	????	????	-0.11	-0.09	-0.07	-0.06	-0.04	-0.04	-0.03	????	????
4	????	????	????	-0.17	-0.14	-0.11	-0.09	-0.08	????	????	????
5	????	????	????	????	-0.24	-0.20	-0.16	????	????	????	????
6	????	????	????	????	????	-0.33	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	-0.15	-0.12	-0.10	-0.08	-0.06	-0.04	-0.03	-0.02	-0.02	????
3	????	????	-0.29	-0.23	-0.19	-0.15	-0.12	-0.10	-0.08	????	????
4	????	????	????	-0.43	-0.35	-0.29	-0.23	-0.19	????	????	????
5	????	????	????	????	-0.60	-0.50	-0.41	????	????	????	????
6	????	????	????	????	????	-0.83	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.63	0.64	0.66	0.69	0.72	0.77	0.84	0.92	1.03	????
3	????	????	0.62	0.62	0.62	0.63	0.63	0.64	0.64	????	????
4	????	????	????	0.61	0.61	0.61	0.60	0.60	????	????	????
5	????	????	????	????	0.61	0.60	0.60	????	????	????	????
6	????	????	????	????	????	0.61	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.90	????
4	????	????	0.90	0.04	0.04	0.03	0.03	0.03	0.90	????	????
5	????	????	????	0.90	0.04	0.04	0.04	0.90	????	????	????
6	????	????	????	????	0.90	0.05	0.90	????	????	????	????

D=25.0000000 TDX= 0.20
 TDTO= 1.00 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	-0.06	-0.05	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	????
3	????	????	-0.15	-0.13	-0.11	-0.10	-0.08	-0.07	-0.06	????	????
4	????	????	????	-0.33	-0.28	-0.23	-0.19	-0.16	????	????	????
5	????	????	????	????	-0.72	-0.55	-0.50	????	????	????	????
6	????	????	????	????	????	-4.04	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	-0.35	-0.29	-0.23	-0.19	-0.15	-0.12	-0.10	-0.08	-0.06	????
3	????	????	-0.90	-0.74	-0.60	-0.50	-0.41	-0.34	-0.28	????	????
4	????	????	????	-2.03	-1.67	-1.37	-1.13	-0.93	????	????	????
5	????	????	????	????	-4.52	-3.70	-3.04	????	????	????	????
6	????	????	????	????	????	*****	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.83	0.83	0.83	0.82	0.82	0.82	0.81	0.81	0.81	????
3	????	????	0.83	0.82	0.82	0.81	0.80	0.79	0.78	????	????
4	????	????	????	0.84	0.83	0.83	0.83	0.82	????	????	????
5	????	????	????	????	0.84	0.85	0.84	????	????	????	????
6	????	????	????	????	????	0.60	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.90	????
4	????	????	0.90	0.04	0.03	0.03	0.03	0.03	0.90	????	????
5	????	????	????	0.90	0.05	0.04	0.04	0.90	????	????	????
6	????	????	????	????	0.90	0.08	0.90	????	????	????	????

D=1.0000000

TDX= 0.50

TDTO= 0.50

C= 1.00

F= 0.10

ROO= 0.90

PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.18	0.12	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.01	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	?????	-0.11	-0.06	-0.03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	?????
3	?????	?????	-0.15	-0.09	-0.05	-0.03	-0.02	-0.01	-0.01	?????	?????
4	?????	?????	?????	-0.17	-0.10	-0.06	-0.04	-0.02	?????	?????	?????
5	?????	?????	?????	?????	-0.18	-0.11	-0.07	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.19	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.18	0.12	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.01	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	?????	-0.11	-0.06	-0.03	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	?????
3	?????	?????	-0.15	-0.09	-0.05	-0.03	-0.02	-0.02	-0.02	?????	?????
4	?????	?????	?????	-0.17	-0.10	-0.06	-0.04	-0.02	?????	?????	?????
5	?????	?????	?????	?????	-0.19	-0.11	-0.07	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.19	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	0.03	0.02	-0.01	-0.07	-0.10	0.01	0.09	0.12	0.13	?????
3	?????	?????	0.02	0.00	-0.02	-0.03	0.02	0.11	0.21	?????	?????
4	?????	?????	?????	0.02	0.00	0.00	0.02	0.10	?????	?????	?????
5	?????	?????	?????	?????	0.02	0.02	0.03	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.03	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.90	?????
4	?????	?????	0.90	0.10	0.08	0.07	0.06	0.05	0.90	?????	?????
5	?????	?????	?????	0.90	0.10	0.08	0.07	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.09	0.90	?????	?????	?????	?????

D=0.1600000 TDX= 0.50
 TDTO= 0.20 C= 1.00
 F= 0.10 RCO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.18	0.12	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.01	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	????	-0.10	-0.05	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	????
3	????	????	-0.13	-0.07	-0.04	-0.02	-0.02	-0.02	-0.02	????	????
4	????	????	????	-0.12	-0.07	-0.04	-0.03	-0.02	????	????	????
5	????	????	????	????	-0.10	-0.06	-0.04	????	????	????	????
6	????	????	????	????	????	-0.08	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.18	0.12	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.01	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	????	-0.09	-0.04	0.00	0.01	0.00	0.00	-0.01	-0.01	-0.02	????
3	????	????	-0.11	-0.05	-0.01	0.00	-0.01	-0.01	-0.01	????	????
4	????	????	????	-0.10	-0.06	-0.01	-0.01	-0.01	????	????	????
5	????	????	????	????	-0.09	-0.05	-0.03	????	????	????	????
6	????	????	????	????	????	-0.07	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.11	-0.25	51.94	2.77	2.24	-4.30	-0.39	-0.12	-0.05	????
3	????	????	-0.18	-0.40	-5.26	-6.67	-2.14	-0.64	-0.24	????	????
4	????	????	????	-0.20	-0.17	-2.74	-1.81	-0.84	????	????	????
5	????	????	????	????	-0.11	-0.20	0.00	????	????	????	????
6	????	????	????	????	????	-0.14	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.20	0.14	0.11	0.08	0.07	0.06	0.06	0.90	????
4	????	????	0.90	0.15	0.11	0.09	0.07	0.06	0.90	????	????
5	????	????	????	0.90	0.12	0.09	0.07	0.90	????	????	????
6	????	????	????	????	0.90	0.10	0.90	????	????	????	????

D=4.0000000 TDX= 0.50
 TDT0= 1.00 C= 1.00
 F= 0.10 RO0= 0.90 P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.18	0.12	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.01	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	????	-0.11	-0.07	-0.04	-0.02	-0.01	-0.01	-0.01	0.00	0.00	????
3	????	????	-0.22	-0.14	-0.09	-0.06	-0.03	-0.01	0.00	????	????
4	????	????	????	-0.35	-0.22	-0.13	-0.08	-0.04	????	????	????
5	????	????	????	????	-0.54	-0.33	-0.20	????	????	????	????
6	????	????	????	????	????	-0.85	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.18	0.12	0.08	0.06	0.04	0.03	0.01	0.00	-0.01	-0.01	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	????	-0.26	-0.15	-0.09	-0.05	-0.03	-0.02	-0.02	-0.02	-0.01	????
3	????	????	-0.50	-0.31	-0.19	-0.11	-0.07	-0.04	-0.02	????	????
4	????	????	????	-0.84	-0.51	-0.31	-0.19	-0.11	????	????	????
5	????	????	????	????	-1.37	-0.83	-0.50	????	????	????	????
6	????	????	????	????	????	-2.24	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.57	0.55	0.53	0.51	0.50	0.55	0.65	0.76	0.83	????
3	????	????	0.56	0.54	0.52	0.51	0.55	0.71	1.14	????	????
4	????	????	????	0.58	0.58	0.57	0.59	0.63	????	????	????
5	????	????	????	????	0.61	0.61	0.61	????	????	????	????
6	????	????	????	????	????	0.62	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.90	????
4	????	????	0.90	0.10	0.08	0.07	0.06	0.05	0.90	????	????
5	????	????	????	0.90	0.11	0.08	0.07	0.90	????	????	????
6	????	????	????	????	0.90	0.14	0.90	????	????	????	????

D=0.0400000 **TDX= 1.00**
TDTO= 0.20 **C= 1.00**
F= 0.10 **ROO= 0.90** **PO= 0.90**

0	1	2	3	4	5	6	7	8	9	10	11
0	0.37	0.15	0.07	0.02	-0.01	-0.01	0.00	0.01	0.02	0.01	-0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	?????	-0.12	-0.03	-0.02	-0.02	-0.02	-0.01	0.01	0.02	0.01	?????
3	?????	?????	-0.09	-0.04	-0.03	-0.02	-0.01	0.01	0.02	?????	?????
4	?????	?????	?????	-0.06	-0.03	-0.02	-0.01	0.01	?????	?????	?????
5	?????	?????	?????	?????	-0.04	-0.02	-0.01	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.37	0.15	0.07	0.02	-0.01	-0.01	0.00	0.01	0.02	0.01	-0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	?????	-0.10	-0.01	-0.01	-0.01	-0.02	0.00	0.01	0.02	0.01	?????
3	?????	?????	-0.07	-0.04	-0.01	-0.02	0.00	0.01	0.02	?????	?????
4	?????	?????	?????	-0.05	-0.02	-0.02	0.00	0.01	?????	?????	?????
5	?????	?????	?????	?????	-0.03	-0.01	0.00	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.01	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.20	2.00	1.00	-0.36	-0.10	-0.13	0.04	0.02	0.02	?????
3	?????	?????	-0.29	0.00	-0.71	-0.22	-0.28	0.09	0.05	?????	?????
4	?????	?????	?????	-0.20	-1.09	-0.37	-0.46	0.14	?????	?????	?????
5	?????	?????	?????	?????	-0.33	-0.58	-0.72	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.92	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.33	0.18	0.13	0.11	0.10	0.10	0.10	0.90	?????
4	?????	?????	0.90	0.19	0.13	0.11	0.10	0.11	0.90	?????	?????
5	?????	?????	?????	0.90	0.13	0.10	0.10	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.10	0.90	?????	?????	?????	?????

D=0.2500000 **TDX= 1.00**
TDTO= 0.50 **C= 1.00**
F= 0.10 **ROO= 0.90** **PO= 0.90**

0	1	2	3	4	5	6	7	8	9	10	11
0	0.37	0.15	0.07	0.02	-0.01	-0.01	0.00	0.01	0.02	0.01	-0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	????	-0.12	-0.04	-0.02	-0.02	-0.02	0.00	0.01	0.01	0.01	????
3	????	????	-0.11	-0.04	-0.02	-0.01	0.00	0.00	0.01	????	????
4	????	????	????	-0.08	-0.03	-0.01	0.00	0.00	????	????	????
5	????	????	????	????	-0.04	-0.01	0.00	????	????	????	????
6	????	????	????	????	????	-0.01	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.37	0.15	0.07	0.02	-0.01	-0.01	0.00	0.01	0.02	0.01	-0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	????	-0.11	-0.03	-0.01	-0.02	-0.02	0.00	0.01	0.02	0.01	????
3	????	????	-0.09	-0.03	-0.02	-0.01	0.00	0.01	0.01	????	????
4	????	????	????	-0.07	-0.02	-0.01	0.00	0.00	????	????	????
5	????	????	????	????	-0.03	-0.01	0.00	????	????	????	????
6	????	????	????	????	????	-0.01	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.09	-0.33	-1.22	-0.12	0.04	0.02	0.14	0.13	0.13	????
3	????	????	-0.22	-0.33	-0.34	0.02	-0.04	0.41	0.35	????	????
4	????	????	????	-0.15	-0.72	-0.27	-0.39	-0.31	????	????	????
5	????	????	????	????	-0.33	0.00	-1.87	????	????	????	????
6	????	????	????	????	????	0.00	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.20	0.13	0.11	0.10	0.10	0.11	0.11	0.90	????
4	????	????	0.90	0.14	0.11	0.09	0.10	0.11	0.90	????	????
5	????	????	????	0.90	0.11	0.09	0.10	0.90	????	????	????
6	????	????	????	????	0.90	0.10	0.90	????	????	????	????

D=0.1600000 TDX= 0.50

TDTO= 0.20 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90 $f(x) = \frac{1}{x}$, $g(x) = -e^{-x-a}$ **Sayısal Çözüm**

0	1	2	3	4	5	6	7	8	9	10	11
0	2.11	1.07	0.71	0.52	0.42	0.34	0.29	0.25	0.22	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	?????	1.04	0.65	0.49	0.39	0.33	0.28	0.25	0.22	0.20	?????
3	?????	?????	0.67	0.48	0.39	0.32	0.28	0.25	0.22	?????	?????
4	?????	?????	?????	0.49	0.39	0.32	0.28	0.25	?????	?????	?????
5	?????	?????	?????	?????	0.40	0.33	0.28	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.33	?????	?????	?????	?????	?????

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	2.11	1.07	0.71	0.52	0.42	0.34	0.29	0.25	0.22	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	?????	1.02	0.63	0.52	0.41	0.34	0.29	0.25	0.22	0.20	?????
3	?????	?????	0.67	0.47	0.42	0.35	0.29	0.26	0.23	?????	?????
4	?????	?????	?????	0.48	0.37	0.33	0.30	0.26	?????	?????	?????
5	?????	?????	?????	?????	0.40	0.32	0.27	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.32	?????	?????	?????	?????	?????

İzafi Hata

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.02	-0.03	0.07	0.05	0.04	0.03	0.02	0.01	0.01	?????
3	?????	?????	0.00	-0.02	0.09	0.07	0.05	0.03	0.02	?????	?????
4	?????	?????	?????	-0.02	-0.05	0.03	0.07	0.05	?????	?????	?????
5	?????	?????	?????	?????	0.00	-0.03	-0.03	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.03	?????	?????	?????	?????	?????

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.90	?????
4	?????	?????	0.90	0.06	0.06	0.06	0.05	0.05	0.90	?????	?????
5	?????	?????	?????	0.90	0.05	0.05	0.05	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.04	0.90	?????	?????	?????	?????

D=0.2500000 TDX= 1.00
 TDTO= 0.50 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.14	0.55	0.35	0.26	0.20	0.17	0.14	0.13	0.11	0.10	0.09
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	?????	0.53	0.34	0.25	0.20	0.17	0.14	0.13	0.11	0.10	?????
3	?????	?????	0.37	0.26	0.21	0.17	0.15	0.13	0.11	?????	?????
4	?????	?????	?????	0.28	0.22	0.18	0.15	0.13	?????	?????	?????
5	?????	?????	?????	?????	0.24	0.19	0.16	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.20	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.14	0.55	0.35	0.26	0.20	0.17	0.14	0.13	0.11	0.10	0.09
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	?????	0.52	0.34	0.27	0.21	0.17	0.15	0.13	0.11	0.10	?????
3	?????	?????	0.36	0.29	0.22	0.18	0.15	0.13	0.11	?????	?????
4	?????	?????	?????	0.27	0.24	0.19	0.16	0.13	?????	?????	?????
5	?????	?????	?????	?????	0.23	0.20	0.16	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.21	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.01	0.00	0.06	0.03	0.02	0.01	0.01	0.01	0.01	?????
3	?????	?????	-0.03	0.10	0.06	0.03	0.02	0.01	0.01	?????	?????
4	?????	?????	?????	-0.03	0.08	0.05	0.03	0.02	?????	?????	?????
5	?????	?????	?????	?????	-0.04	0.07	0.04	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.04	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.90	?????
4	?????	?????	0.90	0.08	0.09	0.09	0.10	0.10	0.90	?????	?????
5	?????	?????	?????	0.90	0.08	0.09	0.09	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.08	0.90	?????	?????	?????	?????

D=0.0400000 **TDX= 1.00**
TDTO= 0.20 **C= 1.00**
F= 0.10 **ROO= 0.90** **PO= 0.90**

0	1	2	3	4	5	6	7	8	9	10	11
0	1.14	0.55	0.35	0.26	0.20	0.17	0.14	0.13	0.11	0.10	0.09
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	?????	0.46	0.32	0.24	0.20	0.17	0.14	0.13	0.11	0.10	?????
3	?????	?????	0.31	0.24	0.20	0.17	0.14	0.13	0.11	?????	?????
4	?????	?????	?????	0.24	0.20	0.17	0.14	0.13	?????	?????	?????
5	?????	?????	?????	?????	0.20	0.17	0.14	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.17	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.14	0.55	0.35	0.26	0.20	0.17	0.14	0.13	0.11	0.10	0.09
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	?????	0.45	0.32	0.25	0.20	0.17	0.14	0.13	0.11	0.10	?????
3	?????	?????	0.31	0.25	0.20	0.17	0.14	0.13	0.11	?????	?????
4	?????	?????	?????	0.24	0.21	0.17	0.14	0.13	?????	?????	?????
5	?????	?????	?????	?????	0.21	0.17	0.15	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.17	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.02	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	?????
3	?????	?????	0.00	0.04	0.00	0.01	0.01	0.00	0.00	?????	?????
4	?????	?????	?????	0.00	0.04	0.02	0.01	0.01	?????	?????	?????
5	?????	?????	?????	?????	0.06	0.03	0.01	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.04	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.17	0.12	0.11	0.10	0.10	0.10	0.10	0.90	?????
4	?????	?????	0.90	0.12	0.11	0.10	0.10	0.10	0.90	?????	?????
5	?????	?????	?????	0.90	0.10	0.10	0.10	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.10	0.90	?????	?????	?????	?????

$D=1.0000000$ $TDX=0.50$
 $TDTO=0.50$ $C=0.70$
 $F=0.10$ $ROO=0.90$ $P0=0.90$

0	1	2	3	4	5	6	7	8	9	10	11
0	2.15	1.09	0.72	0.53	0.42	0.35	0.29	0.25	0.22	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	???	1.38	0.73	0.51	0.40	0.33	0.29	0.25	0.22	0.20	???
3	???	???	1.09	0.60	0.43	0.35	0.30	0.26	0.23	???	???
4	???	???	???	0.92	0.52	0.39	0.32	0.27	???	???	???
5	???	???	???	???	0.79	0.47	0.35	???	???	???	???
6	???	???	???	???	???	0.70	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
0	2.15	1.09	0.72	0.53	0.42	0.35	0.29	0.25	0.22	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	???	1.40	0.75	0.57	0.43	0.35	0.30	0.26	0.23	0.20	???
3	???	???	1.11	0.63	0.49	0.38	0.31	0.27	0.24	???	???
4	???	???	???	0.93	0.53	0.43	0.34	0.28	???	???	???
5	???	???	???	???	0.78	0.51	0.38	???	???	???	???
6	???	???	???	???	???	0.69	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	???	0.01	0.03	0.10	0.07	0.05	0.04	0.03	0.02	0.01	???
3	???	???	0.01	0.05	0.10	0.08	0.06	0.04	0.03	???	???
4	???	???	???	0.01	0.02	0.09	0.07	0.05	???	???	???
5	???	???	???	???	-0.01	0.07	0.07	???	???	???	???
6	???	???	???	???	???	-0.01	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	???	0.90	-0.01	0.04	0.05	0.05	0.05	0.05	0.05	0.90	???
4	???	???	0.90	-0.03	0.02	0.04	0.04	0.04	0.90	???	???
5	???	???	???	0.90	-0.03	0.02	0.03	0.90	???	???	???
6	???	???	???	???	0.90	-0.02	0.90	???	???	???	???

D=1.0000000 TDX= 0.20

TDTO= 0.20 C= 0.70

F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	5.08	2.57	1.72	1.29	1.04	0.86	0.74	0.65	0.57	0.51	0.47
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	?????	3.60	1.90	1.32	1.02	0.84	0.71	0.62	0.55	0.49	?????
3	?????	?????	2.92	1.59	1.12	0.88	0.73	0.63	0.55	?????	?????
4	?????	?????	?????	2.46	1.38	0.99	0.78	0.66	?????	?????	?????
5	?????	?????	?????	?????	2.12	1.23	0.89	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	1.86	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	5.08	2.57	1.72	1.29	1.04	0.86	0.74	0.65	0.57	0.51	0.47
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	?????	3.63	1.93	1.35	1.09	0.88	0.74	0.64	0.57	0.51	?????
3	?????	?????	2.95	1.60	1.15	0.95	0.78	0.67	0.59	?????	?????
4	?????	?????	?????	2.45	1.40	1.01	0.85	0.67	?????	?????	?????
5	?????	?????	?????	?????	2.16	1.26	0.89	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	1.86	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.00	0.01	0.02	0.06	0.05	0.04	0.04	0.04	0.03	?????
3	?????	?????	0.01	0.00	0.02	0.07	0.07	0.06	0.06	?????	?????
4	?????	?????	?????	-0.01	0.01	0.01	0.08	0.01	?????	?????	?????
5	?????	?????	?????	?????	0.02	0.03	0.00	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.00	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.19	-0.04	0.00	0.02	0.02	0.03	0.03	0.90	?????
4	?????	?????	0.90	-0.22	-0.07	-0.02	0.00	0.01	0.90	?????	?????
5	?????	?????	?????	0.90	-0.21	-0.08	-0.03	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.20	0.90	?????	?????	?????	?????

D=6.2500000 TDX= 0.20
 TDTO= 0.50 C= 0.90
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	5.07	2.55	1.71	1.29	1.03	0.86	0.73	0.64	0.57	0.51	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	77777	11.82	3.97	2.15	1.44	1.08	0.86	0.72	0.62	0.55	77777
3	77777	77777	40.24	9.25	3.85	2.15	1.42	1.05	0.83	77777	77777
4	77777	77777	77777	*****	27.12	8.70	3.95	2.24	77777	77777	77777
5	77777	77777	77777	77777	*****	92.16	23.55	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	*****	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	5.07	2.55	1.71	1.29	1.03	0.86	0.73	0.64	0.57	0.51	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	77777	-0.62	-1.33	-4.71	5.26	1.90	1.22	0.91	0.74	0.63	77777
3	77777	77777	-0.41	-0.68	-1.22	-3.14	10.18	2.17	1.27	77777	77777
4	77777	77777	77777	-0.31	-0.45	-0.67	-1.09	-2.35	77777	77777	77777
5	77777	77777	77777	77777	-0.25	-0.33	-0.45	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	-0.21	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	77777	20.21	3.97	1.46	0.73	0.43	0.29	0.21	0.16	0.13	77777
3	77777	77777	99.08	14.68	4.16	1.68	0.86	0.52	0.35	77777	77777
4	77777	77777	77777	*****	61.75	14.05	4.62	1.95	77777	77777	77777
5	77777	77777	77777	77777	*****	*****	53.19	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	*****	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	77777	0.90	-0.81	-0.30	-0.14	-0.07	-0.03	-0.01	0.00	0.90	77777
4	77777	77777	0.90	-2.54	-0.85	-0.37	-0.18	-0.10	0.90	77777	77777
5	77777	77777	77777	0.90	-8.36	-2.34	-0.89	0.90	77777	77777	77777
6	77777	77777	77777	77777	0.90	*****	0.90	77777	77777	77777	77777

D=25.0000000 TDX= 0.20
 TDTO= 1.00 C= 0.90
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	5.07	2.55	1.71	1.29	1.03	0.86	0.73	0.64	0.57	0.51	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	77777	39.95	11.00	4.96	2.85	1.88	1.36	1.06	0.85	0.72	77777
3	77777	77777	*****	96.77	30.65	13.02	6.68	3.93	2.55	77777	77777
4	77777	77777	77777	*****	*****	*****	92.47	37.87	77777	77777	77777
5	77777	77777	77777	77777	*****	*****	*****	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	*****	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	5.07	2.55	1.71	1.29	1.03	0.86	0.73	0.64	0.57	0.51	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	77777	-0.13	-0.21	-0.31	-0.45	-0.67	-1.09	-2.35	*****	2.63	77777
3	77777	77777	-0.09	-0.12	-0.16	-0.21	-0.26	-0.34	-0.44	77777	77777
4	77777	77777	77777	-0.06	-0.08	-0.10	-0.13	-0.15	77777	77777	77777
5	77777	77777	77777	77777	-0.05	-0.06	-0.08	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	-0.04	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	77777	*****	53.79	17.13	7.37	3.82	2.25	1.45	1.00	0.73	77777
3	77777	77777	*****	*****	*****	64.46	26.44	12.61	6.74	77777	77777
4	77777	77777	77777	*****	*****	*****	*****	*****	*****	77777	77777
5	77777	77777	77777	77777	*****	*****	*****	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	*****	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	77777	0.90	-1.66	-0.65	-0.31	-0.17	-0.10	-0.06	-0.03	0.90	77777
4	77777	77777	0.90	*****	-4.98	-1.98	-0.94	-0.50	0.90	77777	77777
5	77777	77777	77777	0.90	*****	*****	*****	0.90	77777	77777	77777
6	77777	77777	77777	77777	0.90	*****	0.90	77777	77777	77777	77777

$$D=1.0000000$$

$$TDX=0.5$$

$$TDTO=0.50$$

$$C=0.50$$

$$F=0.10$$

$$ROO=0.90$$

$$PO=0.90$$

$$f(x)=\frac{1}{x}, g(x)=\cos(x)$$

Sayısal Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	1.99	0.99	0.66	0.50	0.40	0.34	0.29	0.26	0.23	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	???	1.34	0.75	0.53	0.41	0.34	0.28	0.25	0.22	0.20	???
3	???	???	1.03	0.62	0.45	0.35	0.29	0.25	0.22	???	???
4	???	???	???	0.82	0.52	0.38	0.30	0.26	???	???	???
5	???	???	???	???	0.67	0.44	0.33	???	???	???	???
6	???	???	???	???	???	0.56	???	???	???	???	???

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	1.99	0.99	0.66	0.50	0.40	0.34	0.29	0.26	0.23	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	???	1.36	0.77	0.55	0.45	0.40	0.33	0.28	0.25	0.22	???
3	???	???	1.05	0.65	0.47	0.41	0.33	0.28	0.25	???	???
4	???	???	???	0.84	0.55	0.43	0.34	0.29	???	???	???
5	???	???	???	???	0.66	0.46	0.36	???	???	???	???
6	???	???	???	???	???	0.55	???	???	???	???	???

İzafi Hata

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	???	0.01	0.03	0.04	0.08	0.16	0.15	0.13	0.12	0.10	???
3	???	???	0.02	0.05	0.04	0.14	0.14	0.13	0.11	???	???
4	???	???	???	0.02	0.05	0.11	0.12	0.11	???	???	???
5	???	???	???	???	-0.02	0.04	0.07	???	???	???	???
6	???	???	???	???	???	-0.02	???	???	???	???	???

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	???	0.90	-0.03	0.02	0.04	0.05	0.05	0.05	0.05	0.90	???
4	???	???	0.90	-0.03	0.02	0.04	0.05	0.05	0.90	???	???
5	???	???	???	0.90	-0.01	0.02	0.04	0.90	???	???	???
6	???	???	???	???	0.90	0.00	0.90	???	???	???	???

D=0.1600000 TDX= 0.50
 TDTO= 0.20 C= 0.90
 F= 0.10 RCO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.99	0.99	0.66	0.50	0.40	0.34	0.29	0.26	0.23	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	????	1.10	0.70	0.51	0.40	0.33	0.28	0.24	0.22	0.20	????
3	????	????	0.76	0.53	0.41	0.33	0.27	0.24	0.21	????	????
4	????	????	????	0.57	0.42	0.33	0.27	0.23	????	????	????
5	????	????	????	????	0.44	0.34	0.27	????	????	????	????
6	????	????	????	????	????	0.35	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.99	0.99	0.66	0.50	0.40	0.34	0.29	0.26	0.23	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	????	1.12	0.73	0.53	0.43	0.34	0.33	0.28	0.25	0.22	????
3	????	????	0.78	0.54	0.42	0.34	0.33	0.28	0.25	????	????
4	????	????	????	0.58	0.44	0.34	0.34	0.28	????	????	????
5	????	????	????	????	0.45	0.35	0.34	????	????	????	????
6	????	????	????	????	????	0.35	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.01	0.04	0.04	0.07	0.03	0.16	0.14	0.13	0.10	????
3	????	????	0.03	0.02	0.02	0.03	0.18	0.16	0.14	????	????
4	????	????	????	0.02	0.05	0.03	0.19	0.18	????	????	????
5	????	????	????	????	0.02	0.03	0.20	????	????	????	????
6	????	????	????	????	????	0.00	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.01	0.03	0.05	0.06	0.07	0.07	0.06	0.90	????
4	????	????	0.90	0.00	0.04	0.05	0.06	0.06	0.90	????	????
5	????	????	????	0.90	0.02	0.04	0.06	0.90	????	????	????
6	????	????	????	????	0.90	0.03	0.90	????	????	????	????

$D=1.0000000$ $TDX=0.20$
 $TDO=0.20$ $C=0.40$
 $F=0.10$ $RO=0.90$ $P0=0.90$

0	1	2	3	4	5	6	7	8	9	10	11
0	5.00	2.50	1.66	1.25	1.00	0.83	0.71	0.62	0.56	0.50	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	77777	3.17	1.84	1.32	1.04	0.85	0.73	0.63	0.56	0.50	77777
3	77777	77777	2.33	1.48	1.11	0.90	0.75	0.65	0.57	77777	77777
4	77777	77777	77777	1.84	1.25	0.97	0.80	0.68	77777	77777	77777
5	77777	77777	77777	77777	1.51	1.08	0.86	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	1.28	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	5.00	2.50	1.66	1.25	1.00	0.83	0.71	0.62	0.56	0.50	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	77777	3.19	1.86	1.37	1.06	0.86	0.74	0.63	0.56	0.50	77777
3	77777	77777	2.35	1.50	1.13	0.92	0.76	0.65	0.57	77777	77777
4	77777	77777	77777	1.86	1.27	0.99	0.82	0.67	77777	77777	77777
5	77777	77777	77777	77777	1.49	1.11	0.89	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	1.26	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	77777	0.00	0.01	0.04	0.02	0.01	0.01	0.00	0.00	0.00	77777
3	77777	77777	0.00	0.01	0.02	0.02	0.01	0.00	0.00	77777	77777
4	77777	77777	77777	0.01	0.02	0.02	0.02	0.01	77777	77777	77777
5	77777	77777	77777	77777	-0.02	0.03	0.03	77777	77777	77777	77777
6	77777	77777	77777	77777	77777	0.02	77777	77777	77777	77777	77777

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	77777	0.90	-0.13	-0.04	-0.01	0.00	0.01	0.01	0.02	0.90	77777
4	77777	77777	0.90	-0.13	-0.05	-0.02	0.00	0.00	0.90	77777	77777
5	77777	77777	77777	0.90	-0.10	-0.04	-0.02	0.90	77777	77777	77777
6	77777	77777	77777	77777	0.90	-0.08	0.90	77777	77777	77777	77777

D=6.2500000 TDX= 0.20
 TDTO= 0.50 C= 0.70
 F= 0.10 ROO= 0.90 P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	5.00	2.50	1.66	1.25	1.00	0.83	0.71	0.62	0.56	0.50	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	????	9.80	3.49	1.98	1.37	1.04	0.85	0.71	0.62	0.54	????
3	????	????	26.28	6.63	3.01	1.80	1.26	0.96	0.78	????	????
4	????	????	????	81.40	15.23	5.46	2.76	1.71	????	????	????
5	????	????	????	????	*****	40.03	11.49	????	????	????	????
6	????	????	????	????	????	*****	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	5.00	2.50	1.66	1.25	1.00	0.83	0.71	0.62	0.56	0.50	0.46
1	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
2	????	-2.42	10.67	2.53	1.55	1.14	0.91	0.76	0.66	0.58	????
3	????	????	-1.21	-4.62	5.33	1.96	1.26	0.95	0.77	????	????
4	????	????	????	-0.81	-1.73	-9.76	3.56	1.63	????	????	????
5	????	????	????	????	-0.61	-1.04	-2.31	????	????	????	????
6	????	????	????	????	????	-0.48	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	5.04	0.67	0.22	0.12	0.08	0.07	0.06	0.06	0.06	????
3	????	????	22.68	2.44	0.44	0.08	0.00	-0.01	-0.01	????	????
4	????	????	????	????	*****	9.80	1.56	0.22	-0.05	????	????
5	????	????	????	????	????	*****	39.43	5.98	????	????	????
6	????	????	????	????	????	????	*****	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.64	-0.24	-0.11	-0.06	-0.03	-0.01	0.00	0.90	????
4	????	????	0.90	-1.65	-0.57	-0.25	-0.13	-0.07	0.90	????	????
5	????	????	????	0.90	-4.38	-1.30	-0.52	0.90	????	????	????
6	????	????	????	????	0.90	*****	0.90	????	????	????	????

D=0.0400000

TDX= 1.00

TDTO= 0.20

C= 0.70

F= 0.10

ROO= 0.90

PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.49	0.34	0.27	0.21	0.16	0.13	0.11	0.11	0.12	0.11
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	0.52	0.33	0.23	0.19	0.17	0.16	0.14	0.11	0.08	????
3	????	????	0.33	0.22	0.18	0.18	0.18	0.15	0.11	????	????
4	????	????	????	0.21	0.17	0.18	0.19	0.16	????	????	????
5	????	????	????	????	0.16	0.19	0.21	????	????	????	????
6	????	????	????	????	????	0.19	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.49	0.34	0.27	0.21	0.16	0.13	0.11	0.11	0.12	0.11
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	0.53	0.34	0.24	0.19	0.20	0.17	0.14	0.13	0.11	????
3	????	????	0.35	0.23	0.18	0.20	0.17	0.14	0.13	????	????
4	????	????	????	0.21	0.17	0.20	0.17	0.14	????	????	????
5	????	????	????	????	0.15	0.20	0.19	????	????	????	????
6	????	????	????	????	????	0.20	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.02	0.03	0.04	0.00	0.14	0.04	0.03	0.13	0.24	????
3	????	????	0.06	0.04	0.00	0.12	-0.06	-0.06	0.15	????	????
4	????	????	????	0.00	0.00	0.09	-0.15	-0.14	????	????	????
5	????	????	????	????	0.06	0.07	0.10	????	????	????	????
6	????	????	????	????	????	0.05	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.12	0.17	0.15	0.08	0.02	0.04	0.11	0.90	????
4	????	????	0.90	0.17	0.15	0.08	0.03	0.04	0.90	????	????
5	????	????	????	0.90	0.14	0.08	0.03	0.90	????	????	????
6	????	????	????	????	0.90	0.08	0.90	????	????	????	????

D=0.2500000 TDX= 1.00
 TDTO= 0.50 C= 0.50
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.49	0.34	0.27	0.21	0.16	0.13	0.11	0.11	0.12	0.11
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	0.55	0.34	0.24	0.19	0.17	0.16	0.14	0.11	0.08	????
3	????	????	0.35	0.23	0.18	0.18	0.18	0.15	0.11	????	????
4	????	????	????	0.23	0.18	0.19	0.19	0.16	????	????	????
5	????	????	????	????	0.19	0.19	0.20	????	????	????	????
6	????	????	????	????	????	0.20	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.98	0.49	0.34	0.27	0.21	0.16	0.13	0.11	0.11	0.12	0.11
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	0.56	0.35	0.24	0.19	0.20	0.17	0.14	0.13	0.11	????
3	????	????	0.36	0.24	0.18	0.20	0.17	0.14	0.13	????	????
4	????	????	????	0.23	0.18	0.20	0.17	0.14	????	????	????
5	????	????	????	????	0.20	0.21	0.17	????	????	????	????
6	????	????	????	????	????	0.21	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.02	0.03	0.00	0.00	0.14	0.04	0.03	0.13	0.24	????
3	????	????	0.03	0.05	0.00	0.11	-0.05	-0.05	0.14	????	????
4	????	????	????	0.00	0.00	0.09	-0.12	-0.12	????	????	????
5	????	????	????	????	0.05	0.07	-0.16	????	????	????	????
6	????	????	????	????	????	0.06	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.09	0.12	0.12	0.09	0.07	0.08	0.10	0.90	????
4	????	????	0.90	0.11	0.11	0.09	0.07	0.08	0.90	????	????
5	????	????	????	0.90	0.10	0.09	0.08	0.90	????	????	????
6	????	????	????	????	0.90	0.09	0.90	????	????	????	????

D=4.0000000 TDX= 0.50
 TDTO= 1.00 C= 0.90
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	1.99	0.99	0.66	0.50	0.40	0.34	0.29	0.26	0.23	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	?????	3.41	1.27	0.74	0.52	0.39	0.32	0.27	0.24	0.21	?????
3	?????	?????	7.66	2.08	1.00	0.62	0.45	0.35	0.29	?????	?????
4	?????	?????	?????	19.59	4.02	1.58	0.86	0.56	?????	?????	?????
5	?????	?????	?????	?????	54.29	8.74	2.79	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	*****	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	1.99	0.99	0.66	0.50	0.40	0.34	0.29	0.26	0.23	0.20	0.18
1	2.00	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2	?????	-0.89	5.26	1.04	0.63	0.46	0.37	0.31	0.26	0.23	?????
3	?????	?????	-0.45	-1.52	2.63	0.83	0.52	0.39	0.31	?????	?????
4	?????	?????	?????	-0.30	-0.61	-2.40	1.75	0.71	?????	?????	?????
5	?????	?????	?????	?????	-0.22	-0.37	-0.76	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.18	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	4.82	0.76	0.29	0.18	0.14	0.13	0.12	0.10	0.08	?????
3	?????	?????	18.15	2.38	0.62	0.25	0.14	0.11	0.08	?????	?????
4	?????	?????	?????	66.82	7.61	1.66	0.51	0.20	?????	?????	?????
5	?????	?????	?????	?????	*****	24.45	4.69	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	*****	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.22	-0.06	0.00	0.02	0.03	0.04	0.04	0.90	?????
4	?????	?????	0.90	-0.55	-0.17	-0.05	-0.01	0.02	0.90	?????	?????
5	?????	?????	?????	0.90	-1.31	-0.38	-0.14	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-3.17	0.90	?????	?????	?????	?????

D=1.0000000

TDX= 0.20

TDTO= 0.20

C= 1.00

F= 0.10

ROO= 0.90

P0= 0.90

$$f(x)=\frac{1}{x+1}, g(x)=\frac{1}{x+1}$$

Sayısal Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.80	0.67	0.57	0.50	0.44	0.40	0.36	0.33	0.31	0.29	0.27
1	1.00	0.83	0.71	0.63	0.56	0.50	0.45	0.42	0.38	0.36	0.33
2	????	1.05	0.89	0.77	0.68	0.61	0.55	0.51	0.47	0.43	????
3	????	????	1.10	0.94	0.82	0.73	0.66	0.60	0.55	????	????
4	????	????	????	1.16	1.00	0.88	0.78	0.71	????	????	????
5	????	????	????	????	1.21	1.04	0.92	????	????	????	????
6	????	????	????	????	????	1.26	????	????	????	????	????

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.80	0.67	0.57	0.50	0.44	0.40	0.36	0.33	0.31	0.29	0.27
1	1.00	0.83	0.71	0.63	0.56	0.50	0.45	0.42	0.38	0.36	0.33
2	????	1.03	0.87	0.76	0.66	0.60	0.53	0.51	0.47	0.43	????
3	????	????	1.08	0.75	0.81	0.72	0.65	0.60	0.55	????	????
4	????	????	????	1.14	0.90	0.87	0.78	0.71	????	????	????
5	????	????	????	????	1.20	1.03	0.92	????	????	????	????
6	????	????	????	????	????	1.25	????	????	????	????	????

İzafi Hata

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.02	-0.02	-0.01	-0.03	-0.02	-0.04	0.00	0.00	0.00	????
3	????	????	-0.02	-0.03	-0.01	-0.01	-0.02	0.00	0.00	????	????
4	????	????	????	-0.02	-0.10	-0.01	0.00	0.00	????	????	????
5	????	????	????	????	-0.01	-0.00	0.00	????	????	????	????
6	????	????	????	????	????	-0.00	????	????	????	????	????

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.14	-0.11	-0.09	-0.08	-0.07	-0.06	-0.05	0.90	????
4	????	????	0.90	-0.14	-0.11	-0.09	-0.08	-0.07	0.90	????	????
5	????	????	????	0.90	-0.13	-0.11	-0.09	0.90	????	????	????
6	????	????	????	????	0.90	-0.13	0.90	????	????	????	????

D=1.0000000

TDX= 0.50

TDTO= 0.50

C= 1.00

F= 0.10

ROO= 0.90

PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09	0.08
1	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18	0.17
2	???	1.17	0.82	0.63	0.52	0.44	0.38	0.34	0.30	0.28	???
3	???	???	1.30	0.94	0.74	0.62	0.53	0.46	0.41	???	???
4	???	???	???	1.41	1.03	0.83	0.70	0.61	???	???	???
5	???	???	???	???	1.50	1.11	0.91	???	???	???	???
6	???	???	???	???	???	1.57	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09	0.08
1	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18	0.17
2	???	1.15	0.81	0.62	0.51	0.42	0.37	0.34	0.30	0.28	???
3	???	???	1.28	0.92	0.73	0.61	0.52	0.46	0.41	???	???
4	???	???	???	1.40	1.01	0.82	0.69	0.61	???	???	???
5	???	???	???	???	1.49	1.10	0.90	???	???	???	???
6	???	???	???	???	???	1.56	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	???	-0.02	-0.01	-0.02	-0.02	-0.05	-0.03	0.00	0.00	0.00	???
3	???	???	-0.02	-0.02	-0.02	-0.02	-0.02	0.00	0.00	???	???
4	???	???	???	-0.00	-0.02	-0.01	-0.01	0.00	???	???	???
5	???	???	???	???	-0.00	-0.00	-0.01	???	???	???	???
6	???	???	???	???	???	-0.00	???	???	???	???	???

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	???	0.90	-0.24	-0.16	-0.12	-0.09	-0.07	-0.06	-0.04	0.90	???
4	???	???	0.90	-0.22	-0.15	-0.11	-0.08	-0.06	0.90	???	???
5	???	???	???	0.90	-0.21	-0.14	-0.10	0.90	???	???	???
6	???	???	???	???	0.90	-0.21	0.90	???	???	???	???

$D=0.1600000$ $TDX=0.50$
 $TDTO=0.20$ $C=1.00$
 $F=0.10$ $ROO=0.90$ $P0=0.90$

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09	0.08
1	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18	0.17
2	?????	1.03	0.76	0.61	0.50	0.43	0.38	0.33	0.30	0.27	?????
3	?????	?????	1.04	0.82	0.68	0.58	0.50	0.45	0.40	?????	?????
4	?????	?????	?????	1.05	0.86	0.73	0.64	0.56	?????	?????	?????
5	?????	?????	?????	?????	1.05	0.89	0.77	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	1.05	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09	0.08
1	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18	0.17
2	?????	1.02	0.73	0.59	0.48	0.42	0.37	0.32	0.30	0.27	?????
3	?????	?????	1.03	0.80	0.67	0.57	0.49	0.44	0.40	?????	?????
4	?????	?????	?????	1.04	0.85	0.72	0.63	0.56	?????	?????	?????
5	?????	?????	?????	?????	1.04	0.87	0.76	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	1.04	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.00	-0.04	-0.03	-0.04	-0.02	-0.03	-0.03	0.00	0.00	?????
3	?????	?????	-0.00	-0.03	-0.02	-0.02	-0.02	-0.02	0.00	?????	?????
4	?????	?????	?????	-0.00	-0.01	-0.01	-0.02	0.00	?????	?????	?????
5	?????	?????	?????	?????	-0.00	-0.02	-0.01	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.00	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	-0.54	-0.41	-0.33	-0.28	-0.23	-0.20	-0.18	0.90	?????
4	?????	?????	0.90	-0.43	-0.34	-0.28	-0.24	-0.21	0.90	?????	?????
5	?????	?????	?????	0.90	-0.36	-0.29	-0.24	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	-0.30	0.90	?????	?????	?????	?????

D=0.0400000 TDX= 1.00
 TDTO= 0.20 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	1.01	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	????
3	????	????	1.01	0.76	0.60	0.50	0.43	0.38	0.33	????	????
4	????	????	????	1.01	0.81	0.67	0.57	0.50	????	????	????
5	????	????	????	????	1.01	0.84	0.72	????	????	????	????
6	????	????	????	????	????	1.01	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	1.00	0.65	0.47	0.37	0.33	0.29	0.25	0.22	0.20	????
3	????	????	1.00	0.73	0.57	0.50	0.42	0.38	0.33	????	????
4	????	????	????	1.00	0.80	0.66	0.56	0.50	????	????	????
5	????	????	????	????	1.00	0.83	0.71	????	????	????	????
6	????	????	????	????	????	1.00	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.01	-0.03	-0.06	-0.08	0.00	0.00	0.00	0.00	0.00	????
3	????	????	-0.01	-0.04	-0.05	0.00	-0.02	0.00	0.00	????	????
4	????	????	????	-0.01	-0.01	-0.02	-0.02	0.00	????	????	????
5	????	????	????	????	-0.01	-0.01	-0.01	????	????	????	????
6	????	????	????	????	????	-0.01	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-1.42	-1.03	-0.80	-0.65	-0.54	-0.46	-0.40	0.90	????
4	????	????	0.90	-1.04	-0.81	-0.66	-0.55	-0.46	0.90	????	????
5	????	????	????	0.90	-0.82	-0.66	-0.55	0.90	????	????	????
6	????	????	????	????	0.90	-0.67	0.90	????	????	????	????

$D=0.2500000$ $TDX= 1.00$
 $TDTO= 0.50$ $C= 1.00$
 $F= 0.10$ $ROO= 0.90$ $PO= 0.90$

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	1.08	0.69	0.51	0.40	0.34	0.29	0.25	0.22	0.20	????
3	????	????	1.10	0.79	0.62	0.51	0.43	0.38	0.34	????	????
4	????	????	????	1.10	0.85	0.69	0.59	0.51	????	????	????
5	????	????	????	????	1.10	0.89	0.75	????	????	????	????
6	????	????	????	????	????	1.10	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.13	0.11	0.10	0.09
2	????	1.07	0.67	0.49	0.38	0.33	0.28	0.25	0.22	0.20	????
3	????	????	1.09	0.77	0.61	0.50	0.42	0.38	0.34	????	????
4	????	????	????	1.09	0.82	0.68	0.58	0.51	????	????	????
5	????	????	????	????	1.09	0.88	0.74	????	????	????	????
6	????	????	????	????	????	1.09	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.00	-0.02	-0.04	-0.05	-0.03	-0.04	0.00	0.00	0.00	????
3	????	????	-0.00	-0.03	-0.02	-0.02	-0.02	0.00	0.00	????	????
4	????	????	????	-0.00	-0.04	-0.01	-0.02	0.00	????	????	????
5	????	????	????	????	-0.00	-0.01	-0.01	????	????	????	????
6	????	????	????	????	????	-0.00	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	-0.54	-0.36	-0.27	-0.20	-0.16	-0.13	-0.10	0.90	????
4	????	????	0.90	-0.40	-0.28	-0.21	-0.17	-0.13	0.90	????	????
5	????	????	????	0.90	-0.31	-0.23	-0.17	0.90	????	????	????
6	????	????	????	????	0.90	-0.25	0.90	????	????	????	????

D=1.0000000 TDX= 0.20

TDTO= 0.20 C= 1.00

F= 0.10 ROO= 0.90 P0= 0.90 $f(x)=\sin(x)$, $g(x)=\cos(x)$ **Sayısal Çözüm**

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	????
3	????	????	0.01	0.01	0.02	0.02	0.02	0.02	0.02	????	????
4	????	????	????	0.02	0.02	0.02	0.02	0.01	????	????	????
5	????	????	????	????	0.02	0.02	0.01	????	????	????	????
6	????	????	????	????	????	0.01	????	????	????	????	????

Analitik Çözüm

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	????
3	????	????	0.01	0.01	0.02	0.02	0.02	0.02	0.02	????	????
4	????	????	????	0.02	0.02	0.02	0.02	0.02	????	????	????
5	????	????	????	????	0.02	0.02	0.02	????	????	????	????
6	????	????	????	????	????	0.02	????	????	????	????	????

İzafi Hata

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	????
3	????	????	0.02	0.02	0.03	0.03	0.04	0.04	0.04	????	????
4	????	????	????	0.03	0.04	0.05	0.05	0.06	????	????	????
5	????	????	????	????	0.05	0.06	0.07	????	????	????	????
6	????	????	????	????	????	0.07	????	????	????	????	????

Basınç

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.90	????
4	????	????	0.90	0.02	0.02	0.02	0.02	0.02	0.90	????	????
5	????	????	????	0.90	0.02	0.02	0.02	0.90	????	????	????
6	????	????	????	????	0.90	0.02	0.90	????	????	????	????

D=6.2500000 TDX= 0.20
 TDTO= 0.50 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	????
3	????	????	0.01	0.01	0.01	0.01	0.01	0.01	0.01	????	????
4	????	????	????	0.00	0.00	0.00	0.00	0.00	????	????	????
5	????	????	????	????	0.00	-0.01	-0.01	????	????	????	????
6	????	????	????	????	????	-0.01	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	????	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	????
3	????	????	0.02	0.02	0.02	0.02	0.01	0.01	0.01	????	????
4	????	????	????	0.02	0.01	0.01	0.01	0.00	????	????	????
5	????	????	????	????	0.01	0.00	0.00	????	????	????	????
6	????	????	????	????	????	-0.01	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.46	0.39	0.34	0.30	0.26	0.22	0.18	0.14	0.08	????
3	????	????	0.55	0.53	0.52	0.50	0.48	0.45	0.41	????	????
4	????	????	????	0.74	0.81	0.91	1.09	1.53	????	????	????
5	????	????	????	????	1.66	3.51	-7.38	????	????	????	????
6	????	????	????	????	????	-1.22	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.90	????
4	????	????	0.90	0.02	0.02	0.02	0.02	0.02	0.90	????	????
5	????	????	????	0.90	0.02	0.02	0.02	0.90	????	????	????
6	????	????	????	????	0.90	0.02	0.90	????	????	????	????

D=25.0000000 TDX= 0.20
 TDTO= 1.00 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	?????	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	?????
3	?????	?????	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	?????	?????
4	?????	?????	?????	-0.01	-0.01	-0.01	-0.02	-0.02	?????	?????	?????
5	?????	?????	?????	?????	-0.02	0.02	-0.03	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-2.46	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
1	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
2	?????	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	?????
3	?????	?????	0.01	0.01	0.01	0.00	0.00	0.00	-0.01	?????	?????
4	?????	?????	?????	-0.01	-0.01	-0.01	-0.02	-0.02	?????	?????	?????
5	?????	?????	?????	?????	-0.02	-0.02	-0.02	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.00	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	0.79	0.81	0.83	0.85	0.88	0.91	0.94	1.00	1.13	?????
3	?????	?????	1.30	1.77	2.72	6.17	*****	-2.71	-1.26	?????	?????
4	?????	?????	?????	-0.31	-0.15	-0.13	-0.05	-0.06	?????	?????	?????
5	?????	?????	?????	?????	-0.44	2.36	-0.99	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	*****	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.90	?????
4	?????	?????	0.90	0.02	0.02	0.02	0.02	0.02	0.90	?????	?????
5	?????	?????	?????	0.90	0.02	0.02	0.02	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.01	0.90	?????	?????	?????	?????

D=1.0000000 TDX= 0.50
 TDTO= 0.50 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.01	0.00	0.01	0.02	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	?????	0.01	0.02	0.01	0.01	0.00	-0.01	-0.01	-0.02	-0.01	?????
3	?????	?????	0.01	0.01	0.00	-0.01	-0.01	-0.02	-0.01	?????	?????
4	?????	?????	?????	0.00	-0.01	-0.02	-0.02	-0.02	?????	?????	?????
5	?????	?????	?????	?????	-0.02	-0.02	-0.02	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.01	0.00	0.01	0.02	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	?????	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	?????
3	?????	?????	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	?????	?????
4	?????	?????	?????	0.00	-0.01	-0.01	-0.02	-0.02	?????	?????	?????
5	?????	?????	?????	?????	-0.01	-0.02	-0.02	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	0.05	0.09	0.13	0.20	0.64	-0.11	0.03	0.08	0.12	?????
3	?????	?????	0.18	0.35	1.49	-0.45	-0.09	0.04	0.14	?????	?????
4	?????	?????	?????	1.78	-0.71	-0.25	-0.08	0.05	?????	?????	?????
5	?????	?????	?????	?????	-0.30	-0.17	-0.07	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.12	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.05	0.05	0.06	0.06	0.06	0.06	0.05	0.90	?????
4	?????	?????	0.90	0.06	0.06	0.06	0.06	0.05	0.90	?????	?????
5	?????	?????	?????	0.90	0.06	0.06	0.05	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.05	0.90	?????	?????	?????	?????

D=0.1600000 TDX= 0.50
 TDTO= 0.20 C= 1.00
 F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.01	0.00	0.01	0.02	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	?????	0.02	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	?????
3	?????	?????	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02	?????	?????
4	?????	?????	?????	0.02	0.00	-0.01	-0.02	-0.03	?????	?????	?????
5	?????	?????	?????	?????	0.00	-0.02	-0.03	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.01	0.00	0.01	0.02	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	?????	0.01	0.02	0.02	0.01	0.01	-0.01	-0.01	-0.02	-0.02	?????
3	?????	?????	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	?????	?????
4	?????	?????	?????	0.02	0.01	-0.01	-0.01	-0.01	?????	?????	?????
5	?????	?????	?????	?????	0.01	-0.02	-0.03	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.40	-0.16	0.00	0.18	0.59	0.00	-0.52	-0.21	-0.04	?????
3	?????	?????	-0.29	-0.01	0.41	2.07	0.00	-0.79	-0.38	?????	?????
4	?????	?????	?????	-0.01	0.79	0.00	-1.94	-0.96	?????	?????	?????
5	?????	?????	?????	?????	1.53	0.00	0.00	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.00	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.04	0.05	0.06	0.07	0.07	0.07	0.06	0.90	?????
4	?????	?????	0.90	0.05	0.06	0.07	0.07	0.07	0.90	?????	?????
5	?????	?????	?????	0.90	0.06	0.07	0.07	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.07	0.90	?????	?????	?????	?????

D=4.0000000 TDX= 0.50

TDTO= 1.00 C= 1.00

F= 0.10 ROO= 0.90 PO= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.01	0.00	0.01	0.02	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	????	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	????
3	????	????	-0.01	-0.02	-0.02	-0.02	-0.01	0.00	0.01	????	????
4	????	????	????	-0.02	-0.02	-0.01	0.00	0.01	????	????	????
5	????	????	????	????	0.00	0.01	0.01	????	????	????	????
6	????	????	????	????	????	0.02	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.01	0.00	0.01	0.02	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02
1	0.00	0.01	0.01	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02
2	????	0.02	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.01	????
3	????	????	0.00	-0.01	-0.01	-0.02	-0.02	-0.01	0.00	????	????
4	????	????	????	-0.02	-0.02	-0.01	0.00	0.00	????	????	????
5	????	????	????	????	0.00	0.00	0.01	????	????	????	????
6	????	????	????	????	????	0.02	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	0.55	0.68	0.91	2.34	-0.11	0.35	0.51	0.64	0.82	????
3	????	????	4.88	-1.68	-0.46	-0.02	0.33	0.81	2.46	????	????
4	????	????	????	-0.04	0.02	0.11	0.41	-0.57	????	????	????
5	????	????	????	????	1.53	-0.65	0.28	????	????	????	????
6	????	????	????	????	????	-0.06	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.05	0.06	0.06	0.06	0.05	0.05	0.05	0.90	????
4	????	????	0.90	0.06	0.06	0.05	0.05	0.05	0.90	????	????
5	????	????	????	0.90	0.05	0.05	0.05	0.90	????	????	????
6	????	????	????	????	0.90	0.04	0.90	????	????	????	????

D=0.2500000 TDX= 1.00
 TDTO= 0.50 C= 1.00
 F= 0.10 ROO= 0.90 P0= 0.90

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.02	0.01	0.02	0.02	0.00	-0.02	-0.02	0.00	0.02	0.02	0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	?????	0.02	0.00	-0.02	-0.02	-0.01	0.01	0.02	0.01	-0.01	?????
3	?????	?????	-0.01	-0.03	-0.02	0.00	0.03	0.03	0.00	?????	?????
4	?????	?????	?????	-0.04	-0.02	0.01	0.04	0.03	?????	?????	?????
5	?????	?????	?????	?????	-0.02	0.02	0.04	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.02	0.01	0.02	0.02	0.00	-0.02	-0.02	0.00	0.02	0.02	0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	?????	0.02	0.01	-0.01	-0.02	-0.01	0.00	0.02	0.01	0.00	?????
3	?????	?????	-0.01	-0.01	-0.02	0.00	0.01	0.02	0.01	?????	?????
4	?????	?????	?????	-0.02	-0.01	0.00	0.02	0.01	?????	?????	?????
5	?????	?????	?????	?????	0.00	0.01	0.02	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	0.02	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	?????	-0.19	0.53	-1.51	-0.26	0.36	-2.46	-0.34	0.23	-6.90	?????
3	?????	?????	0.00	-1.25	-0.49	1.55	-1.43	-0.59	0.75	?????	?????
4	?????	?????	?????	-1.18	-0.84	-2.38	-1.22	-0.91	?????	?????	?????
5	?????	?????	?????	?????	-2.10	-0.72	-1.11	?????	?????	?????	?????
6	?????	?????	?????	?????	?????	-0.36	?????	?????	?????	?????	?????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	?????	0.90	0.12	0.13	0.12	0.08	0.07	0.08	0.11	0.90	?????
4	?????	?????	0.90	0.13	0.11	0.08	0.07	0.09	0.90	?????	?????
5	?????	?????	?????	0.90	0.10	0.08	0.08	0.90	?????	?????	?????
6	?????	?????	?????	?????	0.90	0.09	0.90	?????	?????	?????	?????

D=0.0400000 TDX= 1.00
 TDTO= 0.20 C= 1.00
 F= 0.10 ROO= 0.90 P0= 0.90

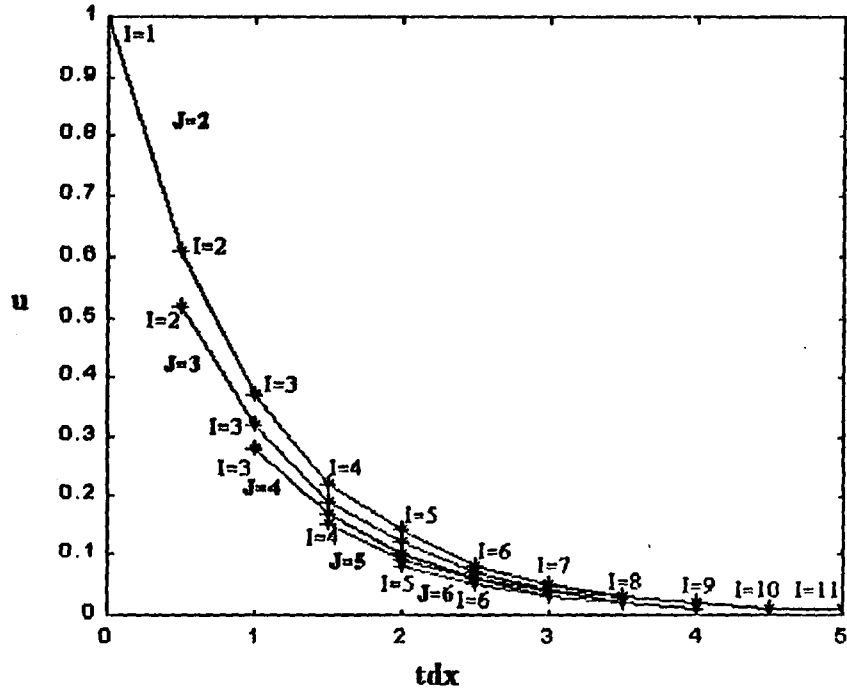
0	1	2	3	4	5	6	7	8	9	10	11
0	-0.02	0.01	0.02	0.02	0.00	-0.02	-0.02	0.00	0.02	0.02	0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	????	0.02	0.01	-0.01	-0.02	-0.01	0.01	0.02	0.01	-0.01	????
3	????	????	0.00	-0.03	-0.03	-0.01	0.03	0.04	0.01	????	????
4	????	????	????	-0.05	-0.04	0.00	0.04	0.05	????	????	????
5	????	????	????	????	-0.05	0.01	0.06	????	????	????	????
6	????	????	????	????	????	0.01	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
0	-0.02	0.01	0.02	0.02	0.00	-0.02	-0.02	0.00	0.02	0.02	0.01
1	0.00	0.01	0.02	0.00	-0.01	-0.02	0.00	0.01	0.02	0.01	-0.01
2	????	0.02	0.01	-0.01	-0.02	-0.02	0.01	0.01	0.02	0.00	????
3	????	????	0.01	-0.02	-0.02	-0.01	0.02	0.02	0.01	????	????
4	????	????	????	-0.04	-0.02	-0.01	0.03	0.04	????	????	????
5	????	????	????	????	-0.03	-0.01	0.05	????	????	????	????
6	????	????	????	????	????	0.01	????	????	????	????	????

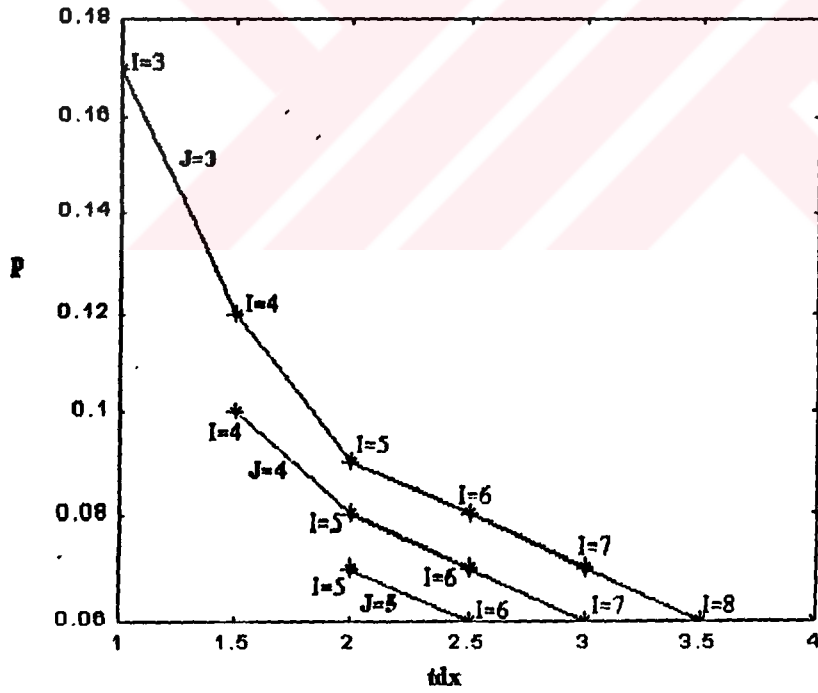
0	1	2	3	4	5	6	7	8	9	10	11
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	????	-0.45	0.43	0.00	-0.59	0.28	0.00	-0.75	0.14	3.31	????
3	????	????	1.01	0.50	-1.06	0.61	-0.50	-1.30	0.30	????	????
4	????	????	????	-0.25	-1.48	1.09	-0.03	-0.25	????	????	????
5	????	????	????	????	-0.67	1.88	-0.20	????	????	????	????
6	????	????	????	????	????	0.00	????	????	????	????	????

0	1	2	3	4	5	6	7	8	9	10	11
1	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
2	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
3	????	0.90	0.14	0.18	0.15	0.08	0.02	0.04	0.11	0.90	????
4	????	????	0.90	0.18	0.15	0.07	0.03	0.05	0.90	????	????
5	????	????	????	0.90	0.14	0.07	0.03	0.90	????	????	????
6	????	????	????	????	0.90	0.07	0.90	????	????	????	????

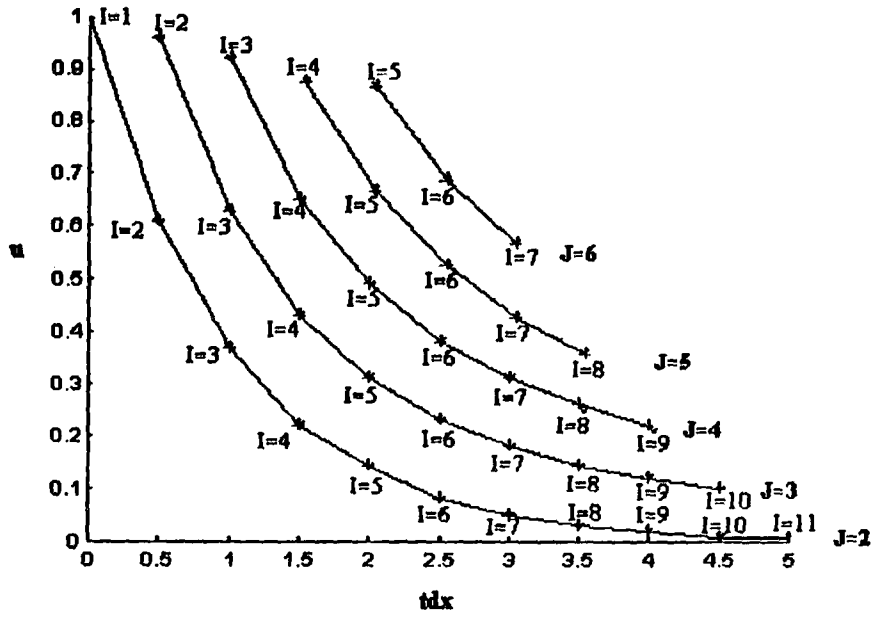
-3



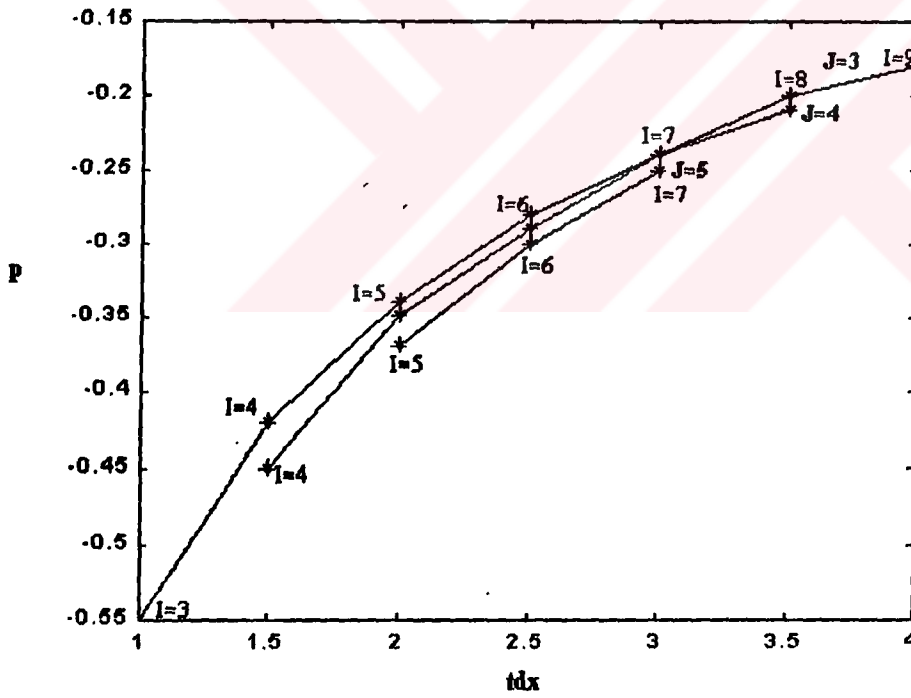
Şekil 1. $f(x)=e^{-x}$, $g(x)=-e^{-x-c}$ sınır şartı için hız dağılımı



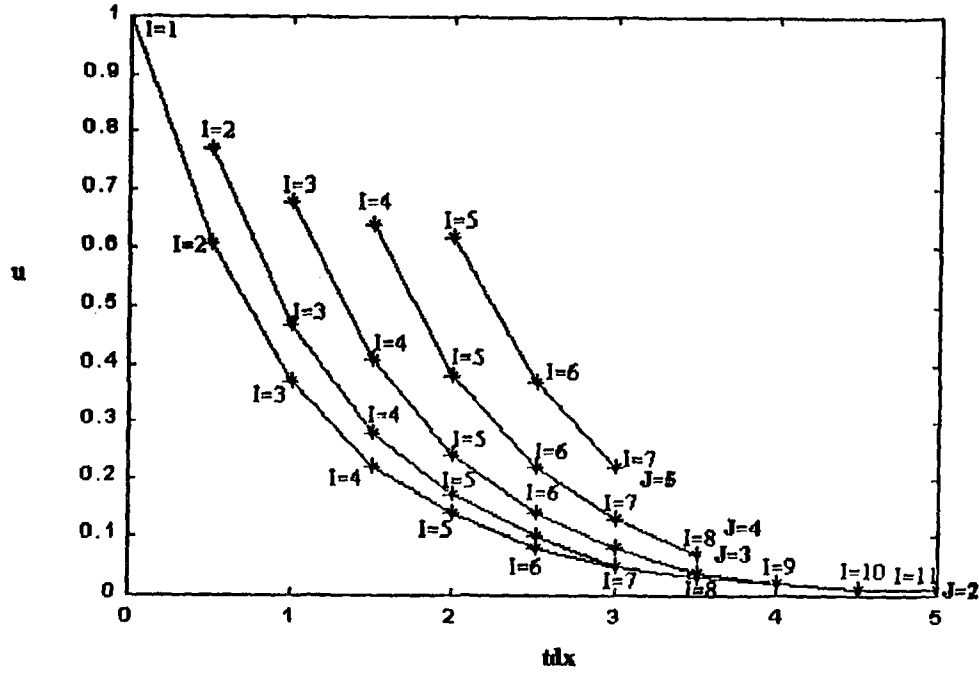
Şekil 2. $f(x)=e^{-x}$, $g(x)=-e^{-x-c}$ sınır şartı için basınç dağılımı



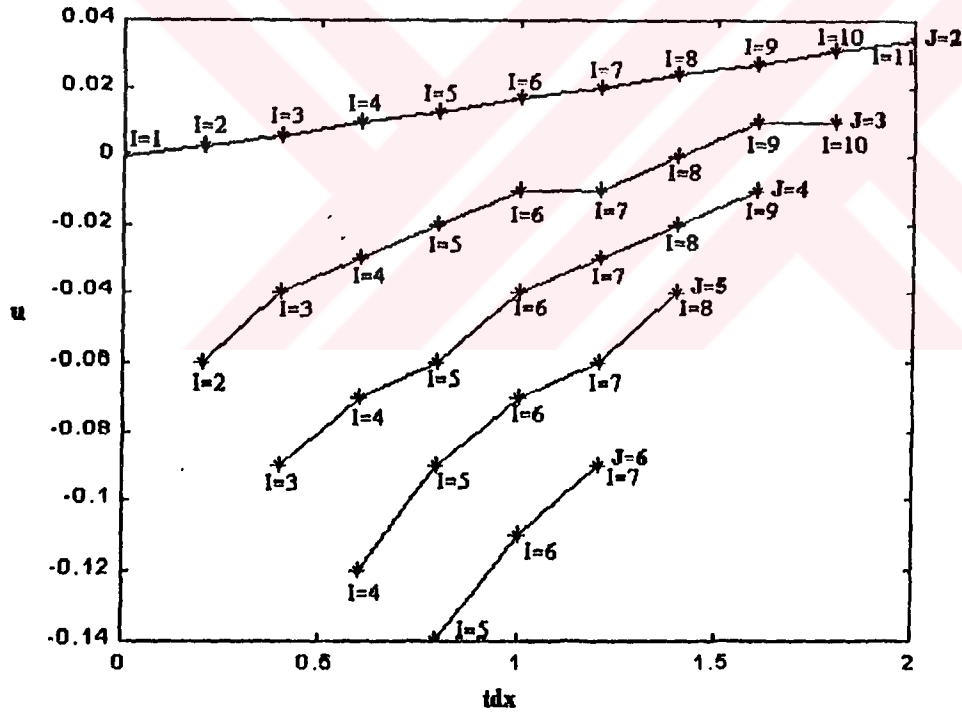
Şekil 3 . $f(x)=e^{-x}$, $g(x)=1/(x+1)$ sınır şartı için hız dağılımı



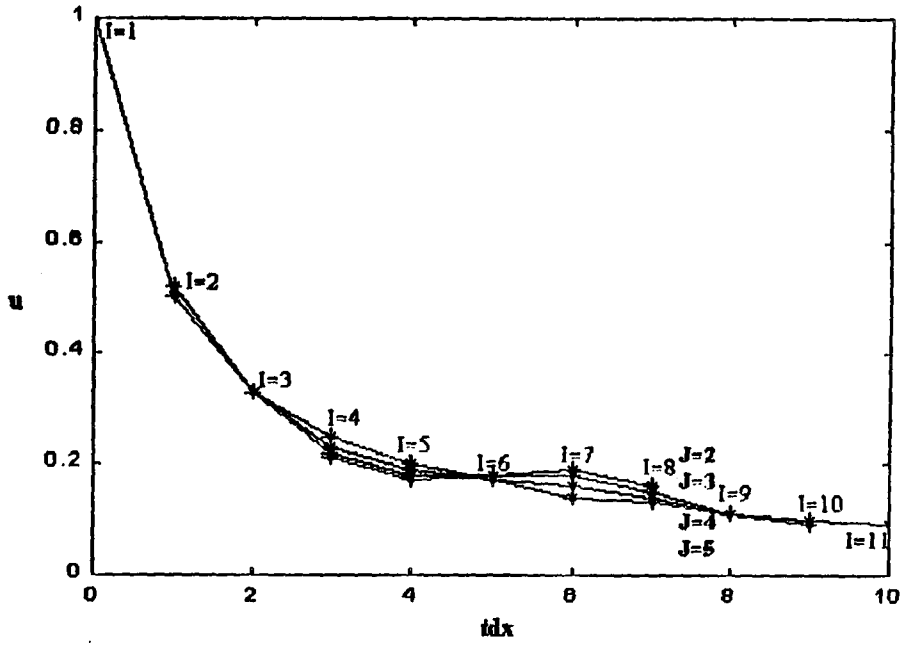
Şekil 4. $f(x)=e^{-x}$, $g(x)=1/(x+1)$ sınır şartı için basınç dağılımı



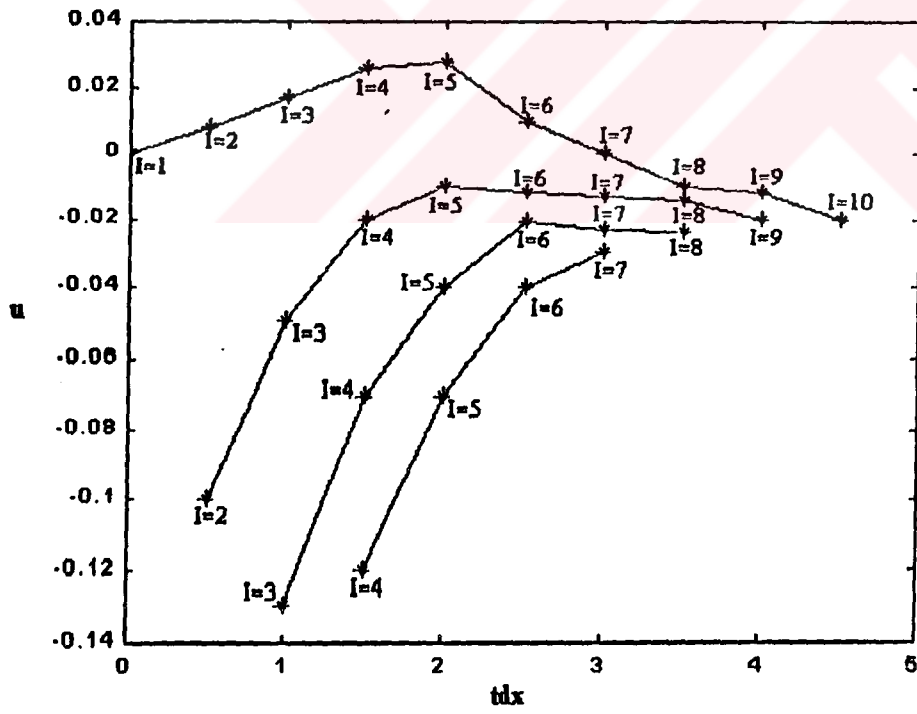
Şekil 5. $f(x)=e^{-x}, g(x)=\cos(x)$ sınır şartı için hız dağılımı



Şekil 6. $f(x)=\sin(x), g(x)=e^{-x}$ sınır şartı için hız dağılımı



Şekil 7. $f(x) = 1/x, g(x) = \cos(x)$ Sınır şartı için hız dağılımı



Şekil 8. $f(x) = \sin(x), g(x) = -e^{-x^2}$ sınır şartı için hız dağılımı