Istanbul Technical University Faculty of Aeronautics and Astronautics **06.06.2017**
2016-2017 Spring Semester
21461 BIL106E Introduction to Scientific and Engineering Computing

Final Exam - SOLUTION

Problem 1: (10p) Find the results of the following expressions.

(a) `0**0 + 0.0`
(b) `TAN(ACOS(1/SQRT(REAL(2))))`
(c) `LOG(10.0) + LOG10(10.0)`
(d) `1/(ICHAR("a")+2)`
(e) `MODULO(LEN("XYZT")*5,3)`
(f) `LEN_TRIM("ABC-1   ")/2`
(g) `LEN(ADJUSTR("ABC-1   ")) [3 trailing blanks]`
(h) `INT(2.0*COS(1.0*ICHAR("#"))+2.0)/5`
(i) `"-"//CHAR(ICHAR("7"))`
(j) `3**1.1**2`

Solution 1:

(a) `1.0`
(b) `1.0`
(c) `3.302585`
(d) `0`
(e) `2`
(f) `2`
(g) `8`
(h) `0`
(i) `-7`
(j) `3.778476`

Problem 2: (10p) What will the output of the following program? The blanks between numbers must be shown.

```
program problem2
integer :: array(2,3) = RESHAPE((/1,0,-8,3,5,-12/),(/2,3/))
print "(4i4)", ((array(i,j),j=3,1,-1), i=2,1,-1)
end program problem2
```

Solution 2:

```
-12  3  0  5
 -8  1
```

Problem 3: (10p) Write a **program** that calculates and displays the volume and surface area of a cylinder, given the radius and height in meters. The volume of such a cylinder is $\pi r^2 h$ and its surface area is $2\pi r^2 + 2\pi rh$.

Solution 3:

```
program problem3
real, parameter :: pi = 3.1415926
real :: r, h
print *, "Enter radius (r) and height (h) of cylinder:"
read *, r, h
print *, "Volume of cylinder =", pi * r ** 2 * h
print *, "Surface area of cylinder =", 2 * pi * r **2 + 2 * pi * r * h
end program problem3
```

Problem 4: (15p) Write a **function** that receives a real number and returns an array having two elements, one of which is the integral part and the other one is the fractional part of that real number. Thus, if the real number –1.23 is passed to the function the array to be returned must be (/–1, – 0.23/).

Useful intrinsic function:

INT (*a*): Converts an argument to an integer by truncating.

Solution 4:

```
function int_fract(x) result(w)
real, intent(in) :: x
real, dimension(2) :: w

w(1) = int(x)
w(2) = x - w(1)
end function int_fract
```

Problem 5: (15p) If an amount of money *P* is deposited into a savings account, compounded yearly, the amount of money accumulated after n years, including interest, is calculated according to the formula

$$A = P(1 + r)^n$$

where

A: is the amount of money accumulated after n years, including interest
P: is the principal (the initial amount you deposit)
r : is the annual rate of interest (percentage)
n: is the number of years the amount is deposited for.

Write a **function** that will accept as input the principal (P), annual rate of interest (r), and number of years (n) and will calculate the amount of money accumulated at the end of n years.

Solution 5:

```
function interest(p, r, n)  result(a)
real, intent(in) :: p, r
integer, intent(in) :: n
real :: a
a = p * (1+r) ** n
end function interest
```

Problem 6: (20p) Write a **subroutine** which finds the row and column numbers of the largest element of a two dimensional integer array $A_{m\times n}$ with no two elements being equal. $A_{m\times n}$ is the input argument of the subroutine. The output argument of the subroutine must be an array that has two elements equal to the row and column numbers of the largest element of the input argument, respectively.

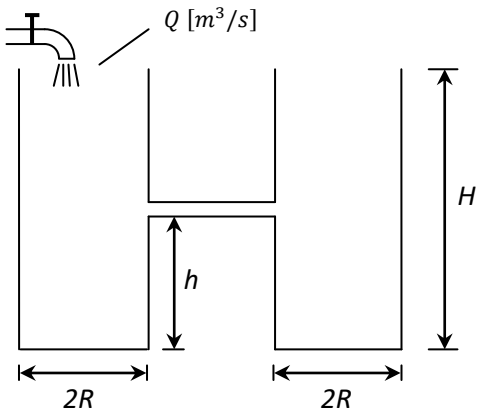
Solution 6:

```
subroutine maxij(a, b)
integer, dimension(:,:), intent(in) :: a
integer, dimension(2) :: b
integer :: i, j, maksimum, imax, jmax

maksimum = a(1,1); imax = 1; jmax = 1
do i = 1, size(a,1)
do j = 1, size(a,2)
if (a(i,j).gt.maksimum) then
maksimum = a(i,j)
imax = i
jmax = j
end if
end do
end do
b = (/imax, jmax/)
end subroutine maxij
```

Problem 7: (30p) Consider two interconnected cylindrical tanks which are empty, initially. The dimensions of the tanks and position of connecting tube are given in the figure below. At time $t = 0$ water starts flowing into the left tank at a constant volumetric rate $Q\ [m^3/s]$. Write a **program** that

- **(a)** reads *Q*, *R*, *h*, and *H*,
- **(b)** finds the time required for water level in left tank to reach *h* (T_1),
- **(c)** finds time required for water level in right tank to reach *h* (T_2),
- **(d)** finds the total amount of time (T_f) required to fill both tanks,
- **(e)** calculates the heights of the water levels in both tanks and stores these data in a file "waterlevels.dat" for the time interval $[0,\ T_f]$ in time increments of $\Delta t = T_f/1000$. Neglect volume of connecting tube.



Solution 7:

```
program problem7
real :: Q, R, h, HH
real :: T1, T2, Tf, t, deltat
real :: A
real, parameter :: pi = 3.1415926
real :: hleft, hright
integer :: i
print *, "Enter (1)Q:Volumetric rate (2)R:radius (3)h:tube height (4)H:cylinder height"
read *, Q, R, h, HH
!Q = 0.00005     ![m^3/s]
!R = 0.5         ![m]
!h = 0.45        ![m]
!HH = 2.0        ![m]
A = pi * R ** 2
T1 = A * h / Q
T2 = 2 * A * h / Q
Tf = 2 * A * HH / Q

deltat = Tf / 1000.0

open(10, file = "waterlevel.dat")
write(10, *)  " t [s]        hleft [m]       hrigth [m]"
write(10, *)  "----------    ----------     ----------"
do i = 0, 1000
t = i * deltat

if (t<=T1) then
hleft = Q * t / A
hright = 0.0
else if (t<=T2) then
hleft = h
hright = Q * (t-T1) / A    !OR hright = Q * t / A - h
else
hleft = h + Q * (t-T2) / A / 2.0    !OR hleft = Q * t / A/2.0
hright = hleft
end if
write(10, "(E11.5, 5x, F11.5, 5x, f11.5)") t, hleft, hright
end do
end program problem7
```