Advance Numerical Technique Laboratory

Lab 7

**Q.1** Solve a partial differential equation using Alternate Direction Implicit (ADI Scheme)

du/dt = k \* (d2u/dx2 + d2u/dy2)

u(0,x,y) = 0 0 <= x,y <= 1

On the boundary : u(t,x,y) = exp(0.2\*pi\*x)\* sin(0.2\*pi\*y)

dx = dy = 1/4, r = 1/6

**Solution** :-

Here, please note that the variable u is twice the size of t/dt. The values at the even indices are actual and the values at the odd indices are the values of t + ½\*dt.

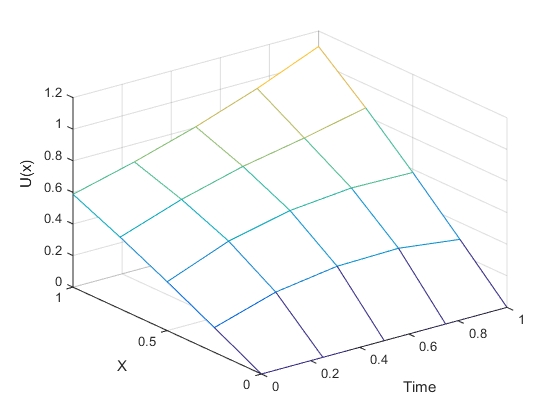


Figure 1. U(x,y) at t=to

u(:,:,1) =

0 0 0 0 0

0 0 0 0 0

0 0 0 0 0

0 0 0 0 0

0 0 0 0 0

u(:,:,2) =

0 0.1564 0.3090 0.4540 0.5878

0 0 0 0 0.6878

0 0 0 0 0.8047

0 0 0 0 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,3) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0130 0.0254 0.0342 0.6878

0 0 0 0 0.8047

0 0.0244 0.0477 0.0642 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,4) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0227 0.0436 0.1120 0.6878

0 0.0065 0.0125 0.0832 0.8047

0 0.0440 0.0843 0.1844 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,5) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0326 0.0658 0.1310 0.6878

0 0.0112 0.0252 0.0884 0.8047

0 0.0616 0.1226 0.2204 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,6) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0416 0.0838 0.1938 0.6878

0 0.0229 0.0503 0.1726 0.8047

0 0.0797 0.1571 0.3135 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,7) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0499 0.1037 0.2044 0.6878

0 0.0298 0.0679 0.1767 0.8047

0 0.0929 0.1876 0.3329 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,8) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0596 0.1227 0.2584 0.6878

0 0.0450 0.0990 0.2551 0.8047

0 0.1106 0.2196 0.4078 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,9) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0670 0.1404 0.2637 0.6878

0 0.0526 0.1172 0.2564 0.8047

0 0.1205 0.2437 0.4168 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,10) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0778 0.1603 0.3116 0.6878

0 0.0700 0.1504 0.3268 0.8047

0 0.1381 0.2734 0.4789 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,11) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0843 0.1757 0.3131 0.6878

0 0.0774 0.1672 0.3252 0.8047

0 0.1454 0.2921 0.4813 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,12) =

0 0.1564 0.3090 0.4540 0.5878

0 0.0963 0.1962 0.3561 0.6878

0 0.0961 0.2003 0.3877 0.8047

0 0.1629 0.3196 0.5339 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,13) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1018 0.2091 0.3549 0.6878

0 0.1025 0.2147 0.3835 0.8047

0 0.1680 0.3340 0.5318 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,14) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1148 0.2298 0.3938 0.6878

0 0.1220 0.2467 0.4388 0.8047

0 0.1855 0.3594 0.5772 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,15) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1191 0.2402 0.3903 0.6878

0 0.1270 0.2582 0.4326 0.8047

0 0.1886 0.3700 0.5721 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,16) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1330 0.2606 0.4256 0.6878

0 0.1469 0.2885 0.4814 0.8047

0 0.2061 0.3936 0.6119 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,17) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1358 0.2685 0.4204 0.6878

0 0.1504 0.2974 0.4736 0.8047

0 0.2073 0.4011 0.6046 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,18) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1503 0.2884 0.4526 0.6878

0 0.1702 0.3257 0.5170 0.8047

0 0.2246 0.4230 0.6400 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,19) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1517 0.2940 0.4460 0.6878

0 0.1721 0.3320 0.5080 0.8047

0 0.2241 0.4279 0.6312 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,20) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1665 0.3133 0.4755 0.6878

0 0.1918 0.3584 0.5467 0.8047

0 0.2413 0.4482 0.6630 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,21) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1664 0.3167 0.4677 0.6878

0 0.1920 0.3625 0.5368 0.8047

0 0.2392 0.4509 0.6530 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,22) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1815 0.3352 0.4948 0.6878

0 0.2114 0.3870 0.5716 0.8047

0 0.2562 0.4699 0.6819 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,23) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1800 0.3367 0.4861 0.6878

0 0.2100 0.3890 0.5609 0.8047

0 0.2527 0.4706 0.6710 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,24) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1951 0.3545 0.5111 0.6878

0 0.2290 0.4117 0.5924 0.8047

0 0.2694 0.4885 0.6976 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,25) =

0 0.1564 0.3090 0.4540 0.5878

0 0.1922 0.3543 0.5016 0.6878

0 0.2262 0.4120 0.5812 0.8047

0 0.2646 0.4876 0.6860 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,26) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2074 0.3713 0.5250 0.6878

0 0.2448 0.4332 0.6099 0.8047

0 0.2812 0.5044 0.7106 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,27) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2032 0.3695 0.5149 0.6878

0 0.2406 0.4319 0.5983 0.8047

0 0.2751 0.5022 0.6986 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,28) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2184 0.3859 0.5367 0.6878

0 0.2588 0.4517 0.6246 0.8047

0 0.2915 0.5181 0.7215 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,29) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2130 0.3828 0.5260 0.6878

0 0.2533 0.4491 0.6127 0.8047

0 0.2844 0.5147 0.7091 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,30) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2281 0.3985 0.5466 0.6878

0 0.2711 0.4676 0.6370 0.8047

0 0.3005 0.5298 0.7307 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,31) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2216 0.3942 0.5355 0.6878

0 0.2645 0.4638 0.6249 0.8047

0 0.2925 0.5254 0.7179 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,32) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2367 0.4094 0.5550 0.6878

0 0.2819 0.4813 0.6475 0.8047

0 0.3084 0.5398 0.7384 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,33) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2292 0.4041 0.5436 0.6878

0 0.2743 0.4765 0.6352 0.8047

0 0.2996 0.5346 0.7254 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,34) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2442 0.4188 0.5621 0.6878

0 0.2914 0.4930 0.6563 0.8047

0 0.3153 0.5484 0.7449 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,35) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2359 0.4126 0.5504 0.6878

0 0.2829 0.4874 0.6439 0.8047

0 0.3057 0.5424 0.7317 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,36) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2507 0.4268 0.5681 0.6878

0 0.2996 0.5031 0.6638 0.8047

0 0.3213 0.5557 0.7503 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,37) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2417 0.4199 0.5562 0.6878

0 0.2903 0.4968 0.6512 0.8047

0 0.3111 0.5491 0.7370 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,38) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2564 0.4338 0.5732 0.6878

0 0.3067 0.5117 0.6702 0.8047

0 0.3265 0.5620 0.7550 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,39) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2467 0.4262 0.5611 0.6878

0 0.2968 0.5048 0.6575 0.8047

0 0.3157 0.5549 0.7415 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,40) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2614 0.4397 0.5776 0.6878

0 0.3129 0.5191 0.6755 0.8047

0 0.3310 0.5674 0.7589 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,41) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2510 0.4315 0.5653 0.6878

0 0.3024 0.5117 0.6628 0.8047

0 0.3197 0.5598 0.7453 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,42) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2656 0.4448 0.5813 0.6878

0 0.3182 0.5254 0.6801 0.8047

0 0.3348 0.5720 0.7622 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,43) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2548 0.4361 0.5689 0.6878

0 0.3072 0.5175 0.6673 0.8047

0 0.3231 0.5640 0.7485 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,44) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2693 0.4491 0.5844 0.6878

0 0.3229 0.5308 0.6840 0.8047

0 0.3382 0.5759 0.7650 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,45) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2580 0.4401 0.5719 0.6878

0 0.3113 0.5226 0.6711 0.8047

0 0.3261 0.5676 0.7513 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,46) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2725 0.4528 0.5871 0.6878

0 0.3268 0.5355 0.6873 0.8047

0 0.3411 0.5793 0.7674 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,47) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2608 0.4434 0.5745 0.6878

0 0.3149 0.5269 0.6744 0.8047

0 0.3287 0.5707 0.7536 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,48) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2752 0.4560 0.5893 0.6878

0 0.3302 0.5394 0.6901 0.8047

0 0.3435 0.5821 0.7695 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,49) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2632 0.4463 0.5767 0.6878

0 0.3180 0.5305 0.6771 0.8047

0 0.3309 0.5733 0.7556 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,50) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2776 0.4587 0.5913 0.6878

0 0.3332 0.5428 0.6924 0.8047

0 0.3457 0.5846 0.7712 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,51) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2653 0.4488 0.5785 0.6878

0 0.3206 0.5337 0.6795 0.8047

0 0.3328 0.5756 0.7573 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,52) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2796 0.4610 0.5929 0.6878

0 0.3357 0.5457 0.6945 0.8047

0 0.3475 0.5867 0.7727 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,53) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2671 0.4509 0.5801 0.6878

0 0.3229 0.5363 0.6815 0.8047

0 0.3344 0.5775 0.7587 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,54) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2813 0.4630 0.5943 0.6878

0 0.3379 0.5481 0.6962 0.8047

0 0.3490 0.5885 0.7739 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,55) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2686 0.4527 0.5815 0.6878

0 0.3248 0.5386 0.6832 0.8047

0 0.3358 0.5791 0.7600 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,56) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2828 0.4647 0.5955 0.6878

0 0.3397 0.5502 0.6977 0.8047

0 0.3504 0.5900 0.7750 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,57) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2699 0.4542 0.5826 0.6878

0 0.3265 0.5406 0.6847 0.8047

0 0.3370 0.5805 0.7610 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,58) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2841 0.4662 0.5965 0.6878

0 0.3413 0.5520 0.6989 0.8047

0 0.3515 0.5913 0.7759 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,59) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2710 0.4555 0.5836 0.6878

0 0.3279 0.5423 0.6859 0.8047

0 0.3380 0.5817 0.7619 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,60) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2852 0.4674 0.5974 0.6878

0 0.3427 0.5536 0.7000 0.8047

0 0.3525 0.5924 0.7767 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,61) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2720 0.4567 0.5844 0.6878

0 0.3291 0.5437 0.6870 0.8047

0 0.3388 0.5827 0.7627 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,62) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2861 0.4685 0.5981 0.6878

0 0.3438 0.5549 0.7009 0.8047

0 0.3534 0.5933 0.7773 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,63) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2728 0.4576 0.5851 0.6878

0 0.3302 0.5449 0.6879 0.8047

0 0.3396 0.5836 0.7633 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,64) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2869 0.4694 0.5988 0.6878

0 0.3448 0.5560 0.7017 0.8047

0 0.3541 0.5942 0.7779 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,65) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2735 0.4584 0.5858 0.6878

0 0.3311 0.5460 0.6886 0.8047

0 0.3402 0.5844 0.7638 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,66) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2876 0.4701 0.5993 0.6878

0 0.3457 0.5570 0.7023 0.8047

0 0.3547 0.5949 0.7784 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,67) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2741 0.4591 0.5863 0.6878

0 0.3318 0.5468 0.6893 0.8047

0 0.3408 0.5850 0.7643 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,68) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2882 0.4708 0.5998 0.6878

0 0.3464 0.5578 0.7029 0.8047

0 0.3552 0.5954 0.7788 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,69) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2746 0.4597 0.5867 0.6878

0 0.3325 0.5476 0.6899 0.8047

0 0.3412 0.5855 0.7647 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,70) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2887 0.4714 0.6002 0.6878

0 0.3470 0.5585 0.7034 0.8047

0 0.3557 0.5959 0.7791 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,71) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2750 0.4602 0.5871 0.6878

0 0.3331 0.5482 0.6903 0.8047

0 0.3416 0.5860 0.7651 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,72) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2891 0.4718 0.6005 0.6878

0 0.3475 0.5591 0.7038 0.8047

0 0.3561 0.5964 0.7794 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,73) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2754 0.4607 0.5874 0.6878

0 0.3335 0.5488 0.6907 0.8047

0 0.3420 0.5864 0.7654 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,74) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2895 0.4722 0.6008 0.6878

0 0.3480 0.5596 0.7041 0.8047

0 0.3564 0.5967 0.7797 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,75) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2757 0.4610 0.5877 0.6878

0 0.3339 0.5493 0.6911 0.8047

0 0.3423 0.5867 0.7656 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,76) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2898 0.4726 0.6010 0.6878

0 0.3484 0.5600 0.7044 0.8047

0 0.3567 0.5971 0.7799 0.9416

0 0.2932 0.5792 0.8510 1.1018

u(:,:,77) =

0 0.1564 0.3090 0.4540 0.5878

0 0.2760 0.4614 0.5879 0.6878

0 0.3343 0.5497 0.6914 0.8047

0 0.3425 0.5870 0.7658 0.9416

0 0.2932 0.5792 0.8510 1.1018