Interrupt Simulator Test Cases

https://github.com/Nhfaris627/SYSC4001

Test Case #	Description	Input	Output
1	Single device basic, simple single device interrupt with one SYSCALL and END_IO	CPU, 50 SYSCALL, 5 CPU, 30 END_IO, 5 CPU, 20	0, 50, CPU burst 50, 1, switch to kernel mode 51, 10, context saved 61, 1, find vector 5 in memory position 0x000A 62, 1, load address 0X048B into the PC 63, 40, execute ISR for device 5 103, 1, IRET 104, 10, context restored 114, 1, switch to user mode 115, 30, CPU burst 145, 1, switch to kernel mode 146, 10, context saved 156, 1, find vector 5 in memory position 0x000A 157, 1, load address 0X048B into the PC 158, 211, complete I/O for device 5 369, 1, IRET 370, 10, context restored 380, 1, switch to user mode 381, 20, CPU burst
2	Multiple different devices with varying I/O times	CPU, 40 SYSCALL, 3 CPU, 25 SYSCALL, 7 CPU, 30 END_IO, 3 CPU, 20 END_IO, 7 CPU, 35	0, 40, CPU burst 40, 1, switch to kernel mode 41, 10, context saved 51, 1, find vector 3 in memory position 0x0006 52, 1, load address 0X042B into the PC 53, 40, execute ISR for device 3 93, 1, IRET 94, 10, context restored 104, 1, switch to user mode 105, 25, CPU burst 130, 1, switch to kernel mode 131, 10, context saved 141, 1, find vector 7 in memory position 0x000E 142, 1, load address 0X00BD into the PC 143, 40, execute ISR for device 7 183, 1, IRET 184, 10, context restored 194, 1, switch to user mode 195, 30, CPU burst 225, 1, switch to kernel mode 226, 10, context saved 236, 1, find vector 3 in memory position 0x0006 237, 1, load address 0X042B into the PC 238, 300, complete I/O for device 3 538, 1, IRET 539, 10, context restored 549, 1, switch to user mode 550, 20, CPU burst

			570, 1, switch to kernel mode 571, 10, context saved 581, 1, find vector 7 in memory position 0x000E 582, 1, load address 0X00BD into the PC 583, 152, complete I/O for device 7 735, 1, IRET 736, 10, context restored 746, 1, switch to user mode 747, 35, CPU burst
3	Back to back syscalls, multiple consecutive SYSCALL operations without CPU bursts	CPU, 10 SYSCALL, 1 SYSCALL, 2 SYSCALL, 3 CPU, 15 END_IO, 1 END_IO, 2 END_IO, 3 CPU, 20	0, 10, CPU burst 10, 1, switch to kernel mode 11, 10, context saved 21, 1, find vector 1 in memory position 0x0002 22, 1, load address 0X029C into the PC 23, 40, execute ISR for device 1 63, 1, IRET 64, 10, context restored 74, 1, switch to user mode 75, 1, switch to kernel mode 76, 10, context saved 86, 1, find vector 2 in memory position 0x0004 87, 1, load address 0X0695 into the PC 88, 40, execute ISR for device 2 128, 1, IRET 129, 10, context restored 139, 1, switch to user mode 140, 1, switch to kernel mode 141, 10, context saved 151, 1, find vector 3 in memory position 0x0006 152, 1, load address 0X042B into the PC 153, 40, execute ISR for device 3 193, 1, IRET 194, 10, context restored 204, 1, switch to user mode 205, 15, CPU burst 220, 1, switch to kernel mode 221, 10, context saved 231, 1, find vector 1 in memory position 0x0002 232, 1, load address 0X029C into the PC 233, 100, complete I/O for device 1 333, 1, IRET 334, 10, context restored 344, 1, switch to user mode 345, 1, switch to kernel mode 346, 10, context saved 356, 1, find vector 2 in memory position 0x0004 357, 1, load address 0X0695 into the PC 358, 150, complete I/O for device 2 508, 1, IRET 509, 10, context restored 519, 1, switch to user mode 520, 1, switch to kernel mode 521, 10, context saved 531, 1, find vector 3 in memory position 0x0006

			532, 1, load address 0X042B into the PC 533, 300, complete I/O for device 3 833, 1, IRET 834, 10, context restored 844, 1, switch to user mode 845, 20, CPU burst
4	Same device multiple interrupts, same device generating multiple interrupts	CPU, 30 SYSCALL, 8 CPU, 20 END_IO, 8 CPU, 25 SYSCALL, 8 CPU, 15 END_IO, 8 CPU, 40	0, 30, CPU burst 30, 1, switch to kernel mode 31, 10, context saved 41, 1, find vector 8 in memory position 0x0010 42, 1, load address 0X06EF into the PC 43, 40, execute ISR for device 8 83, 1, IRET 84, 10, context restored 94, 1, switch to user mode 95, 20, CPU burst 115, 1, switch to kernel mode 116, 10, context saved 126, 1, find vector 8 in memory position 0x0010 127, 1, load address 0X06EF into the PC 128, 1000, complete I/O for device 8 1128, 1, IRET 1129, 10, context restored 1139, 1, switch to user mode 1140, 25, CPU burst 1165, 1, switch to kernel mode 1166, 10, context saved 1176, 1, find vector 8 in memory position 0x0010 1177, 1, load address 0X06EF into the PC 1178, 40, execute ISR for device 8 1218, 1, IRET 1219, 10, context restored 1229, 1, switch to user mode 1230, 15, CPU burst 1245, 1, switch to kernel mode 1246, 10, context saved 1256, 1, find vector 8 in memory position 0x0010 1257, 1, load address 0X06EF into the PC 1258, 1000, complete I/O for device 8 2258, 1, IRET 2259, 10, context restored 2269, 1, switch to user mode 2270, 40, CPU burst
5	Long I/O operation, device with extended I/O completion time	CPU, 100 SYSCALL, 12 CPU, 50 END_IO, 12 CPU, 75	0, 100, CPU burst 100, 1, switch to kernel mode 101, 10, context saved 111, 1, find vector 12 in memory position 0x0018 112, 1, load address 0X03B9 into the PC 113, 40, execute ISR for device 12 153, 1, IRET 154, 10, context restored 164, 1, switch to user mode 165, 50, CPU burst

			215, 1, switch to kernel mode 216, 10, context saved 226, 1, find vector 12 in memory position 0x0018 227, 1, load address 0X03B9 into the PC 228, 145, complete I/O for device 12 373, 1, IRET 374, 10, context restored 384, 1, switch to user mode 385, 75, CPU burst
6	Minimum device number, test with device 0 or 1 (boundary case)	CPU, 45 SYSCALL, 0 CPU, 30 END_IO, 0 CPU, 25	0, 45, CPU burst 45, 1, switch to kernel mode 46, 10, context saved 56, 1, find vector 0 in memory position 0x0000 57, 1, load address 0X01E3 into the PC 58, 40, execute ISR for device 0 98, 1, IRET 99, 10, context restored 109, 1, switch to user mode 110, 30, CPU burst 140, 1, switch to kernel mode 141, 10, context saved 151, 1, find vector 0 in memory position 0x0000 152, 1, load address 0X01E3 into the PC 153, 110, complete I/O for device 0 263, 1, IRET 264, 10, context restored 274, 1, switch to user mode 275, 25, CPU burst
7	Maximum device number, test with device 19 (upper boundary)	CPU, 50 SYSCALL, 19 CPU, 35 END_IO, 19 CPU, 40	0, 50, CPU burst 50, 1, switch to kernel mode 51, 10, context saved 61, 1, find vector 19 in memory position 0x0026 62, 1, load address 0X0765 into the PC 63, 40, execute ISR for device 19 103, 1, IRET 104, 10, context restored 114, 1, switch to user mode 115, 35, CPU burst 150, 1, switch to kernel mode 151, 10, context saved 161, 1, find vector 19 in memory position 0x0026 162, 1, load address 0X0765 into the PC 163, 652, complete I/O for device 19 815, 1, IRET 816, 10, context restored 826, 1, switch to user mode 827, 40, CPU burst
8	CPU only (no interrupts), pure CPU execution without any I/O	CPU, 100 CPU, 150 CPU, 200	0, 100, CPU burst 100, 150, CPU burst 250, 200, CPU burst

9	Interleaved I/O completions, multiple devices with overlapping I/O operations	CPU, 20 SYSCALL, 4 CPU, 10 SYSCALL, 6 CPU, 15 SYSCALL, 9 CPU, 25 END_IO, 4 CPU, 10 END_IO, 6 CPU, 20 END_IO, 9 CPU, 30	0, 20, CPU burst 20, 1, switch to kernel mode 21, 10, context saved 31, 1, find vector 4 in memory position 0x0008 32, 1, load address 0X0292 into the PC 33, 40, execute ISR for device 4 73, 1, IRET 74, 10, context restored 84, 1, switch to user mode 85, 10, CPU burst 95, 1, switch to kernel mode 96, 10, context saved 106, 1, find vector 6 in memory position 0x000C 107, 1, load address 0X0639 into the PC 108, 40, execute ISR for device 6 148, 1, IRET 149, 10, context restored 159, 1, switch to user mode 160, 15, CPU burst 175, 1, switch to kernel mode 176, 10, context saved 186, 1, find vector 9 in memory position 0x0012 187, 1, load address 0X036C into the PC 188, 40, execute ISR for device 9 228, 1, IRET 229, 10, context restored 239, 1, switch to user mode 240, 25, CPU burst 265, 1, switch to kernel mode 266, 10, context saved 276, 1, find vector 4 in memory position 0x0008 277, 1, load address 0X0292 into the PC 278, 250, complete I/O for device 4 528, 1, IRET 529, 10, context restored 539, 1, switch to user mode 540, 10, CPU burst 550, 1, switch to kernel mode 551, 10, context saved 561, 1, find vector 6 in memory position 0x000C 562, 1, load address 0X0639 into the PC 563, 265, complete I/O for device 6 828, 1, IRET 829, 10, context restored 839, 1, switch to user mode 840, 20, CPU burst 860, 1, switch to kernel mode 861, 10, context saved 871, 1, find vector 9 in memory position 0x0012 872, 1, load address 0X036C into the PC 873, 156, complete I/O for device 9 1029, 1, IRET 1030, 10, context restored 1040, 1, switch to user mode 1041, 30, CPU burst

10	Short CPU bursts, minimal CPU burst times between operations	CPU, 5 SYSCALL, 10 CPU, 3 END_IO, 10 CPU, 7 SYSCALL, 11 CPU, 4 END_IO, 11 CPU, 6	0, 5, CPU burst 5, 1, switch to kernel mode 6, 10, context saved 16, 1, find vector 10 in memory position 0x0014 17, 1, load address 0X07B0 into the PC 18, 40, execute ISR for device 10 58, 1, IRET 59, 10, context restored 69, 1, switch to user mode 70, 3, CPU burst 73, 1, switch to kernel mode 74, 10, context saved 84, 1, find vector 10 in memory position 0x0014 85, 1, load address 0X07B0 into the PC 86, 564, complete I/O for device 10 650, 1, IRET 651, 10, context restored 661, 1, switch to user mode 662, 7, CPU burst 669, 1, switch to kernel mode 670, 10, context saved 680, 1, find vector 11 in memory position 0x0016 681, 1, load address 0X01F8 into the PC 682, 40, execute ISR for device 11 722, 1, IRET 723, 10, context restored 733, 1, switch to user mode 734, 4, CPU burst 738, 1, switch to kernel mode 739, 10, context saved 749, 1, find vector 11 in memory position 0x0016 750, 1, load address 0X01F8 into the PC 751, 523, complete I/O for device 11 1274, 1, IRET 1275, 10, context restored 1285, 1, switch to user mode 1286, 6, CPU burst
11	Long CPU bursts, extended CPU execution between interrupts	CPU, 500 SYSCALL, 15 CPU, 600 END_IO, 15 CPU, 400	0, 500, CPU burst 500, 1, switch to kernel mode 501, 10, context saved 511, 1, find vector 15 in memory position 0x001E 512, 1, load address 0X0584 into the PC 513, 40, execute ISR for device 15 553, 1, IRET 554, 10, context restored 564, 1, switch to user mode 565, 600, CPU burst 1165, 1, switch to kernel mode 1166, 10, context saved 1176, 1, find vector 15 in memory position 0x001E 1177, 1, load address 0X0584 into the PC 1178, 68, complete I/O for device 15 1246, 1, IRET 1247, 10, context restored

			1257, 1, switch to user mode 1258, 400, CPU burst
12	High interrupt frequency, many interrupts in quick succession	CPU, 10 SYSCALL, 2 CPU, 5 SYSCALL, 3 CPU, 8 SYSCALL, 5 CPU, 6 SYSCALL, 7 CPU, 12 END_IO, 2 CPU, 5 END_IO, 3 CPU, 7 END_IO, 5 CPU, 9 END_IO, 7 CPU, 15	0, 10, CPU burst 10, 1, switch to kernel mode 11, 10, context saved 21, 1, find vector 2 in memory position 0x0004 22, 1, load address 0X0695 into the PC 23, 40, execute ISR for device 2 63, 1, IRET 64, 10, context restored 74, 1, switch to user mode 75, 5, CPU burst 80, 1, switch to kernel mode 81, 10, context saved 91, 1, find vector 3 in memory position 0x0006 92, 1, load address 0X042B into the PC 93, 40, execute ISR for device 3 133, 1, IRET 134, 10, context restored 144, 1, switch to user mode 145, 8, CPU burst 153, 1, switch to kernel mode 154, 10, context saved 164, 1, find vector 5 in memory position 0x000A 165, 1, load address 0X048B into the PC 166, 40, execute ISR for device 5 206, 1, IRET 207, 10, context restored 217, 1, switch to user mode 218, 6, CPU burst 224, 1, switch to kernel mode 225, 10, context saved 235, 1, find vector 7 in memory position 0x000E 236, 1, load address 0X00BD into the PC 237, 40, execute ISR for device 7 277, 1, IRET 278, 10, context restored 288, 1, switch to user mode 289, 12, CPU burst 301, 1, switch to kernel mode 302, 10, context saved 312, 1, find vector 2 in memory position 0x0004 313, 1, load address 0X0695 into the PC 314, 150, complete I/O for device 2 464, 1, IRET 465, 10, context restored 475, 1, switch to user mode 476, 5, CPU burst 481, 1, switch to kernel mode 482, 10, context saved 492, 1, find vector 3 in memory position 0x0006 493, 1, load address 0X042B into the PC 494, 300, complete I/O for device 3 794, 1, IRET

			795, 10, context restored 805, 1, switch to user mode 806, 7, CPU burst 813, 1, switch to kernel mode 814, 10, context saved 824, 1, find vector 5 in memory position 0x000A 825, 1, load address 0X048B into the PC 826, 211, complete I/O for device 5 1037, 1, IRET 1038, 10, context restored 1048, 1, switch to user mode 1049, 9, CPU burst 1058, 1, switch to kernel mode 1059, 10, context saved 1069, 1, find vector 7 in memory position 0x000E 1070, 1, load address 0X00BD into the PC 1071, 152, complete I/O for device 7 1223, 1, IRET 1224, 10, context restored 1234, 1, switch to user mode 1235, 15, CPU burst
13	Wide device range, using devices across entire range (0-19)	CPU, 30 SYSCALL, 0 CPU, 20 SYSCALL, 10 CPU, 25 SYSCALL, 19 CPU, 15 END_IO, 0 CPU, 10 END_IO, 10 CPU, 20 END_IO, 19 CPU, 30	0, 30, CPU burst 30, 1, switch to kernel mode 31, 10, context saved 41, 1, find vector 0 in memory position 0x0000 42, 1, load address 0X01E3 into the PC 43, 40, execute ISR for device 0 83, 1, IRET 84, 10, context restored 94, 1, switch to user mode 95, 20, CPU burst 115, 1, switch to kernel mode 116, 10, context saved 126, 1, find vector 10 in memory position 0x0014 127, 1, load address 0X07B0 into the PC 128, 40, execute ISR for device 10 168, 1, IRET 169, 10, context restored 179, 1, switch to user mode 180, 25, CPU burst 205, 1, switch to kernel mode 206, 10, context saved 216, 1, find vector 19 in memory position 0x0026 217, 1, load address 0X0765 into the PC 218, 40, execute ISR for device 19 258, 1, IRET 259, 10, context restored 269, 1, switch to user mode 270, 15, CPU burst 285, 1, switch to kernel mode 286, 10, context saved 296, 1, find vector 0 in memory position 0x0000 297, 1, load address 0X01E3 into the PC 298, 110, complete I/O for device 0

			408, 1, IRET 409, 10, context restored 419, 1, switch to user mode 420, 10, CPU burst 430, 1, switch to kernel mode 431, 10, context saved 441, 1, find vector 10 in memory position 0x0014 442, 1, load address 0X07B0 into the PC 443, 564, complete I/O for device 10 1007, 1, IRET 1008, 10, context restored 1018, 1, switch to user mode 1019, 20, CPU burst 1039, 1, switch to kernel mode 1040, 10, context saved 1050, 1, find vector 19 in memory position 0x0026 1051, 1, load address 0X0765 into the PC 1052, 652, complete I/O for device 19 1704, 1, IRET 1705, 10, context restored 1715, 1, switch to user mode 1716, 30, CPU burst
14	Minimal trace, absolute minimum: single CPU burst	CPU, 100	0, 100, CPU burst
15	Alternating pattern, regular alternating CPU and I/O operations	CPU, 50 SYSCALL, 8 CPU, 50 END_IO, 8 CPU, 50 SYSCALL, 8 CPU, 50 END_IO, 8 CPU, 50	0, 50, CPU burst 50, 1, switch to kernel mode 51, 10, context saved 61, 1, find vector 8 in memory position 0x0010 62, 1, load address 0X06EF into the PC 63, 40, execute ISR for device 8 103, 1, IRET 104, 10, context restored 114, 1, switch to user mode 115, 50, CPU burst 165, 1, switch to kernel mode 166, 10, context saved 176, 1, find vector 8 in memory position 0x0010 177, 1, load address 0X06EF into the PC 178, 1000, complete I/O for device 8 1178, 1, IRET 1179, 10, context restored 1189, 1, switch to user mode 1190, 50, CPU burst 1240, 1, switch to kernel mode 1241, 10, context saved 1251, 1, find vector 8 in memory position 0x0010 1252, 1, load address 0X06EF into the PC 1253, 40, execute ISR for device 8 1293, 1, IRET 1294, 10, context restored

			1304, 1, switch to user mode 1305, 50, CPU burst 1355, 1, switch to kernel mode 1356, 10, context saved 1366, 1, find vector 8 in memory position 0x0010 1367, 1, load address 0X06EF into the PC 1368, 1000, complete I/O for device 8 2368, 1, IRET 2369, 10, context restored 2379, 1, switch to user mode 2380, 50, CPU burst
16	Complete all I/O first, all SYSCALL operations followed by all END_IO operations	CPU, 20 SYSCALL, 1 CPU, 15 SYSCALL, 2 CPU, 18 SYSCALL, 3 CPU, 25 END_IO, 1 CPU, 20 END_IO, 2 CPU, 22 END_IO, 3 CPU, 30	0, 20, CPU burst 20, 1, switch to kernel mode 21, 10, context saved 31, 1, find vector 1 in memory position 0x0002 32, 1, load address 0X029C into the PC 33, 40, execute ISR for device 1 73, 1, IRET 74, 10, context restored 84, 1, switch to user mode 85, 15, CPU burst 100, 1, switch to kernel mode 101, 10, context saved 111, 1, find vector 2 in memory position 0x0004 112, 1, load address 0X0695 into the PC 113, 40, execute ISR for device 2 153, 1, IRET 154, 10, context restored 164, 1, switch to user mode 165, 18, CPU burst 183, 1, switch to kernel mode 184, 10, context saved 194, 1, find vector 3 in memory position 0x0006 195, 1, load address 0X042B into the PC 196, 40, execute ISR for device 3 236, 1, IRET 237, 10, context restored 247, 1, switch to user mode 248, 25, CPU burst 273, 1, switch to kernel mode 274, 10, context saved 284, 1, find vector 1 in memory position 0x0002 285, 1, load address 0X029C into the PC 286, 100, complete I/O for device 1 386, 1, IRET 387, 10, context restored 397, 1, switch to user mode 398, 20, CPU burst 418, 1, switch to kernel mode 419, 10, context saved 429, 1, find vector 2 in memory position 0x0004 430, 1, load address 0X0695 into the PC 431, 150, complete I/O for device 2 581, 1, IRET

			582, 10, context restored 592, 1, switch to user mode 593, 22, CPU burst 615, 1, switch to kernel mode 616, 10, context saved 626, 1, find vector 3 in memory position 0x0006 627, 1, load address 0X042B into the PC 628, 300, complete I/O for device 3 928, 1, IRET 929, 10, context restored 939, 1, switch to user mode 940, 30, CPU burst
17	Random realistic workload, randomly generated realistic I/O pattern	CPU, 29 CPU, 64 SYSCALL, 12 CPU, 61 SYSCALL, 16 CPU, 66 SYSCALL, 3 CPU, 20 END_IO, 3 CPU, 56 END_IO, 16 CPU, 68 END_IO, 12 CPU, 24 SYSCALL, 11 CPU, 38 CPU, 28 END_IO, 11 CPU, 65 CPU, 25 CPU, 55 SYSCALL, 0 CPU, 53 SYSCALL, 18 CPU, 25 SYSCALL, 0 CPU, 57	0, 29, CPU burst 29, 64, CPU burst 93, 1, switch to kernel mode 94, 10, context saved 104, 1, find vector 12 in memory position 0x0018 105, 1, load address 0X03B9 into the PC 106, 40, execute ISR for device 12 146, 1, IRET 147, 10, context restored 157, 1, switch to user mode 158, 61, CPU burst 219, 1, switch to kernel mode 220, 10, context saved 230, 1, find vector 16 in memory position 0x0020 231, 1, load address 0X02DF into the PC 232, 40, execute ISR for device 16 272, 1, IRET 273, 10, context restored 283, 1, switch to user mode 284, 66, CPU burst 350, 1, switch to kernel mode 351, 10, context saved 361, 1, find vector 3 in memory position 0x0006 362, 1, load address 0X042B into the PC 363, 40, execute ISR for device 3 403, 1, IRET 404, 10, context restored 414, 1, switch to user mode 415, 20, CPU burst 435, 1, switch to kernel mode 436, 10, context saved 446, 1, find vector 3 in memory position 0x0006 447, 1, load address 0X042B into the PC 448, 300, complete I/O for device 3 748, 1, IRET 749, 10, context restored 759, 1, switch to user mode 760, 56, CPU burst 816, 1, switch to kernel mode 817, 10, context saved 827, 1, find vector 16 in memory position 0x0020 828, 1, load address 0X02DF into the PC

			829, 956, complete I/O for device 16 1785, 1, IRET 1786, 10, context restored 1796, 1, switch to user mode 1797, 68, CPU burst 1865, 1, switch to kernel mode 1866, 10, context saved 1876, 1, find vector 12 in memory position 0x0018 1877, 1, load address 0X03B9 into the PC 1878, 145, complete I/O for device 12 2023, 1, IRET 2024, 10, context restored 2034, 1, switch to user mode 2035, 24, CPU burst 2059, 1, switch to kernel mode 2060, 10, context saved 2070, 1, find vector 11 in memory position 0x0016 2071, 1, load address 0X01F8 into the PC 2072, 40, execute ISR for device 11 2112, 1, IRET 2113, 10, context restored 2123, 1, switch to user mode 2124, 38, CPU burst 2162, 28, CPU burst 2190, 1, switch to kernel mode 2191, 10, context saved 2201, 1, find vector 11 in memory position 0x0016 2202, 1, load address 0X01F8 into the PC 2203, 523, complete I/O for device 11 2726, 1, IRET 2727, 10, context restored 2737, 1, switch to user mode 2738, 65, CPU burst 2803, 25, CPU burst 2828, 55, CPU burst 2883, 1, switch to kernel mode 2884, 10, context saved 2894, 1, find vector 0 in memory position 0x0000 2895, 1, load address 0X01E3 into the PC 2896, 40, execute ISR for device 0 2936, 1, IRET 2937, 10, context restored 2947, 1, switch to user mode 2948, 53, CPU burst 3001, 1, switch to kernel mode 3002, 10, context saved 3012, 1, find vector 18 in memory position 0x0024 3013, 1, load address 0X060A into the PC 3014, 40, execute ISR for device 18 3054, 1, IRET 3055, 10, context restored 3065, 1, switch to user mode 3066, 25, CPU burst 3091, 1, switch to kernel mode 3092, 10, context saved

			3102, 1, find vector 0 in memory position 0x0000 3103, 1, load address 0X01E3 into the PC 3104, 40, execute ISR for device 0 3144, 1, IRET 3145, 10, context restored 3155, 1, switch to user mode 3156, 57, CPU burst
18	Many concurrent devices, multiple devices with overlapping operations	CPU, 10 SYSCALL, 1 CPU, 8 SYSCALL, 2 CPU, 7 SYSCALL, 3 CPU, 9 SYSCALL, 4 CPU, 6 SYSCALL, 5 CPU, 11 END_IO, 1 CPU, 8 END_IO, 2 CPU, 7 END_IO, 3 CPU, 9 END_IO, 4 CPU, 6 END_IO, 5 CPU, 15	0, 10, CPU burst 10, 1, switch to kernel mode 11, 10, context saved 21, 1, find vector 1 in memory position 0x0002 22, 1, load address 0X029C into the PC 23, 40, execute ISR for device 1 63, 1, IRET 64, 10, context restored 74, 1, switch to user mode 75, 8, CPU burst 83, 1, switch to kernel mode 84, 10, context saved 94, 1, find vector 2 in memory position 0x0004 95, 1, load address 0X0695 into the PC 96, 40, execute ISR for device 2 136, 1, IRET 137, 10, context restored 147, 1, switch to user mode 148, 7, CPU burst 155, 1, switch to kernel mode 156, 10, context saved 166, 1, find vector 3 in memory position 0x0006 167, 1, load address 0X042B into the PC 168, 40, execute ISR for device 3 208, 1, IRET 209, 10, context restored 219, 1, switch to user mode 220, 9, CPU burst 229, 1, switch to kernel mode 230, 10, context saved 240, 1, find vector 4 in memory position 0x0008 241, 1, load address 0X0292 into the PC 242, 40, execute ISR for device 4 282, 1, IRET 283, 10, context restored 293, 1, switch to user mode 294, 6, CPU burst 300, 1, switch to kernel mode 301, 10, context saved 311, 1, find vector 5 in memory position 0x000A 312, 1, load address 0X048B into the PC 313, 40, execute ISR for device 5 353, 1, IRET 354, 10, context restored 364, 1, switch to user mode 365, 11, CPU burst 376, 1, switch to kernel mode

			377, 10, context saved 387, 1, find vector 1 in memory position 0x0002 388, 1, load address 0X029C into the PC 389, 100, complete I/O for device 1 489, 1, IRET 490, 10, context restored 500, 1, switch to user mode 501, 8, CPU burst 509, 1, switch to kernel mode 510, 10, context saved 520, 1, find vector 2 in memory position 0x0004 521, 1, load address 0X0695 into the PC 522, 150, complete I/O for device 2 672, 1, IRET 673, 10, context restored 683, 1, switch to user mode 684, 7, CPU burst 691, 1, switch to kernel mode 692, 10, context saved 702, 1, find vector 3 in memory position 0x0006 703, 1, load address 0X042B into the PC 704, 300, complete I/O for device 3 1004, 1, IRET 1005, 10, context restored 1015, 1, switch to user mode 1016, 9, CPU burst 1025, 1, switch to kernel mode 1026, 10, context saved 1036, 1, find vector 4 in memory position 0x0008 1037, 1, load address 0X0292 into the PC 1038, 250, complete I/O for device 4 1288, 1, IRET 1289, 10, context restored 1299, 1, switch to user mode 1300, 6, CPU burst 1306, 1, switch to kernel mode 1307, 10, context saved 1317, 1, find vector 5 in memory position 0x000A 1318, 1, load address 0X048B into the PC 1319, 211, complete I/O for device 5 1530, 1, IRET 1531, 10, context restored 1541, 1, switch to user mode 1542, 15, CPU burst
19	Zero CPU burst,testing with CPU burst of 0 (if allowed)	CPU, 0 SYSCALL, 7 CPU, 30 END_IO, 7 CPU, 0	0, 0, CPU burst 0, 1, switch to kernel mode 1, 10, context saved 11, 1, find vector 7 in memory position 0x000E 12, 1, load address 0X00BD into the PC 13, 40, execute ISR for device 7 53, 1, IRET 54, 10, context restored 64, 1, switch to user mode 65, 30, CPU burst

			95, 1, switch to kernel mode 96, 10, context saved 106, 1, find vector 7 in memory position 0x000E 107, 1, load address 0X00BD into the PC 108, 152, complete I/O for device 7 260, 1, IRET 261, 10, context restored 271, 1, switch to user mode 272, 0, CPU burst
20	Complex realistic scenario, comprehensive test with varied timing and multiple devices	CPU, 51 SYSCALL, 14 CPU, 39 END_IO, 14 CPU, 72 SYSCALL, 19 CPU, 28 END_IO, 19 CPU, 32 SYSCALL, 7 CPU, 25 END_IO, 7 CPU, 11 SYSCALL, 16 CPU, 54 END_IO, 16 CPU, 96 SYSCALL, 8 CPU, 54 END_IO, 8 CPU, 77	0, 51, CPU burst 51, 1, switch to kernel mode 52, 10, context saved 62, 1, find vector 14 in memory position 0x001C 63, 1, load address 0X0165 into the PC 64, 40, execute ISR for device 14 104, 1, IRET 105, 10, context restored 115, 1, switch to user mode 116, 39, CPU burst 155, 1, switch to kernel mode 156, 10, context saved 166, 1, find vector 14 in memory position 0x001C 167, 1, load address 0X0165 into the PC 168, 456, complete I/O for device 14 624, 1, IRET 625, 10, context restored 635, 1, switch to user mode 636, 72, CPU burst 708, 1, switch to kernel mode 709, 10, context saved 719, 1, find vector 19 in memory position 0x0026 720, 1, load address 0X0765 into the PC 721, 40, execute ISR for device 19 761, 1, IRET 762, 10, context restored 772, 1, switch to user mode 773, 28, CPU burst 801, 1, switch to kernel mode 802, 10, context saved 812, 1, find vector 19 in memory position 0x0026 813, 1, load address 0X0765 into the PC 814, 652, complete I/O for device 19 1466, 1, IRET 1467, 10, context restored 1477, 1, switch to user mode 1478, 32, CPU burst 1510, 1, switch to kernel mode 1511, 10, context saved 1521, 1, find vector 7 in memory position 0x000E 1522, 1, load address 0X00BD into the PC 1523, 40, execute ISR for device 7 1563, 1, IRET 1564, 10, context restored 1574, 1, switch to user mode

			1575, 25, CPU burst 1600, 1, switch to kernel mode 1601, 10, context saved 1611, 1, find vector 7 in memory position 0x000E 1612, 1, load address 0X00BD into the PC 1613, 152, complete I/O for device 7 1765, 1, IRET 1766, 10, context restored 1776, 1, switch to user mode 1777, 11, CPU burst 1788, 1, switch to kernel mode 1789, 10, context saved 1799, 1, find vector 16 in memory position 0x0020 1800, 1, load address 0X02DF into the PC 1801, 40, execute ISR for device 16 1841, 1, IRET 1842, 10, context restored 1852, 1, switch to user mode 1853, 54, CPU burst 1907, 1, switch to kernel mode 1908, 10, context saved 1918, 1, find vector 16 in memory position 0x0020 1919, 1, load address 0X02DF into the PC 1920, 956, complete I/O for device 16 2876, 1, IRET 2877, 10, context restored 2887, 1, switch to user mode 2888, 96, CPU burst 2984, 1, switch to kernel mode 2985, 10, context saved 2995, 1, find vector 8 in memory position 0x0010 2996, 1, load address 0X06EF into the PC 2997, 40, execute ISR for device 8 3037, 1, IRET 3038, 10, context restored 3048, 1, switch to user mode 3049, 54, CPU burst 3103, 1, switch to kernel mode 3104, 10, context saved 3114, 1, find vector 8 in memory position 0x0010 3115, 1, load address 0X06EF into the PC 3116, 1000, complete I/O for device 8 4116, 1, IRET 4117, 10, context restored 4127, 1, switch to user mode 4128, 77, CPU burst

Analysis:

The interrupt simulator test cases seem to demonstrate correct simulation of every instruction. CPU bursts, system calls, and END_IO interrupts display timing as expected, as well as state transitions. Test cases follow interrupt handling sequence as expected: switch to kernel mode (1

ms), save context (10 ms), find vector in memory (1 ms), load ISR address (1), execute ISR (40ms for SYSCALL, device delay for END_IO calls), issuing IRET (1 ms), restoring context (10 ms), and switch back to user mode (1 ms). The timestamps for the output logs verify accurate time progression through the interrupt process, with device specific delays correctly handled. Across all 20 test cases, nested interrupts were handled correctly in sequence, maintaining timing and order of operations.

Interrupt Handling Sequence:

To implement interrupt handling, the system first makes a switch to the kernel (1 ms). Afterwards, it saves the context (10 ms), and then looks up the interrupt vector at the calculated memory position (0x0000 + (device_number * 2) (1 ms). It then loads the address (1 ms) and depending on the type of instruction the ISR takes a different amount of time to execute. For SYSCALL, it takes 40 ms. For END_IO, the duration is based on the value in the device table. After the ISR is completed, the system restores context (10ms), issues IRET (1 ms), and swaps back to user mode (1 ms). This demonstrates correct interrupt handling implementation.

Timing Accuracy:

The timing calculations within test cases show precise simulation of the interrupt system. The time for each interrupt event matches the expected duration based on the timing parameters. For example, in test case 1, SYSCALL, 5 begins at 50 ms, and completes the ISR execution at 103. This perfectly matches what was expected: 1 ms for kernel switch, 10 ms for context save, 1 ms for vector lookup, 1 ms for loading address, 40 ms for ISR, 10 ms for restore context, 1 ms for IRET, 1 ms for swap to user mode = 65 ms. At 115 ms the next CPU burst is executed. For the END_IO, 5 interrupt, it takes 1 ms for kernel switch, 10 ms for context save, 1 ms for vector lookup, 1 ms for loading address, 211 ms for ISR, 10 ms for restore context, 1 ms for IRET, 1 ms for swap to user mode = 236 ms. These calculations are accurate across all test cases.

Device-Specific Behaviour:

The system implements device-specific behaviour by using the device table to lookup I/O completion times for END_IO interrupts. Each devices' unique delay is applied when the event is processed. The vector table is accused using the formula 0x0000 + (device_number * 2) to find the vector position, loading the corresponding ISR addresses.

Nested Interrupts:

The test cases show correct handling of nested interrupts, where multiple SYSCALLs occur in sequence before their END_IO interrupts are processed. In test case 3, the program processes 3 SYSCALLs in succession. Each interrupt properly saved context, executed its ISR, and returned before the next interrupt. The END_IO interrupts are processed in order of the trace.

Edge Cases:

The simulator correctly handles situations such as zero-duration CPU bursts and consecutive interrupt processing. Test case 19 shows proper handling of CPU, 0 burst, which is correctly logged. The system also shows processing multiple interrupts in rapid succession without timing conflicts. Test case 12 shows the system handling 4 consecutive SYSCALLs, followed by their END_IO interrupts, with each interrupt isolated and processed. The simulator maintains accurate timekeeping through all sequences tested, handling various input patterns and edge cases.

- Change the value of the save/restore context time from 10, to 20, to 30ms. What do you Observe?

Increasing context save/restore time from between 10 and 30ms shows an increase in total execution time. Interrupt-heavy test cases undergo significantly longer runtimes, while CPU intensive cases show minimal impact. This shows that context switching overhead becomes significant in I/O workloads.

- Vary the ISR activity time from between 40 and 200, what happens when the ISR execution takes too long?

Varying ISR time from 40ms to 200ms shows exponential growth in execution time for interrupt dense workloads. When ISR time exceeds the device I/O delays, it becomes the dominant bottleneck, which increases the total time by significantly in the more complex test cases.

- Ask yourselves other interesting questions and try to answer them through simulations. For instance: what happens if we have addresses of 4 bytes instead of 2? What if we have a faster CPU

- Address Size: When using longer memory addresses, each interrupt took a bit more time to look up where it needed to go. In high interrupt workloads, these extra moments add up to noticeable delays.
- CPU Speed: Making the processor faster does not affect the performance very much since the system would mostly wait on interrupts and device operations.
- Workload Patterns: Systems that handled many quick interrupts spent most of their time on administrative tasks, while those with fewer but longer interruptions could get more work done relative to the overhead.