APPENDIX 4.1

To show that a SRGD design with parameters $b = v - m + r$, $v = 2k$, where k is an odd integer, cannot exist.

Proof. As $v = 2k$, we have $b = 2r$. Hence substituting $b = 2r$ in $b = v - m + r$, we get $v = m + r$. But for a SRGD design $v = mn$. Hence $r = m(n - 1)$. Now $rk - v\lambda_2 = 0$. Hence $\lambda_2 = rk/v = m(n-1)k/2k = m(n-1)/2$.

Now $v = mn = 2k$. As k is an odd integer, therefore m and n cannot both be even simultaneously. Hence m or n must be a multiple of 2, but not of 2^α, where $\alpha \geq 2$; while the other must be odd. Thus, we have two alternatives:

(i) $m = 2t$, where t is an odd positive integer and n is odd, or

(ii) $n = 2s$, where s is an odd positive integer and m is odd.

Suppose (i) holds. Now $k = cm = mn/2 = tn$, so that $c = n/2$. Hence n must be an even integer, which contradicts the requirement in (i) that n be odd. Hence the given design cannot exist.

Next, suppose that (ii) holds. Substituting the value of $n = 2s$ in $\lambda_2 = m(n-1)/2$, we have $\lambda_2 = ms - (m/2)$. As m is odd, λ_2 is fractional which is impossible. Hence the given design cannot exist.

APPENDIX 4.2

To show that a triangular design with parameters satisfying the relations $rk - v\lambda_1 = n(r - \lambda_1)/2$, $b = v - n + r$ and $v = 2k$ cannot exist.

Proof. As $v = 2k$, we have $b = 2r$. Substituting $b = 2r$ in $b = v - n + r$, we get $r = v - n = n(n-1)2 - n = n(n-3)/2$. Also $v = 2k = n(n-1)/2$ gives $k = n(n-1)/4$.

Putting the values of v, r and k in terms of n in $rk - v\lambda_1 = n(r - \lambda_1)/2$, and solving it for λ_1, we get $\lambda_1 = n(n-3)^2/4(n-2)$.

Now from $k = n(n-1)/4$, we see that if n is even, it must be of the form $4t$, (t a positive integer); while if n is odd, $n-1$ must be of the form $4t$, (t a positive integer). Thus, we consider two alternatives for k:

(i) n is even and of form $n = 4t$, or

(ii) n is odd and of form $n = 4t + 1$,

where t is a positive integer.

If (i) holds, then substituting $n = 4t$, in $\lambda_1 = n(n-3)^2/4(n-2)$, we get $\lambda_1 = 4t^2 - 4t + t/(4t-2)$, which is clearly fractional for all positive integral values of t. Hence the given design cannot exist.

Next, suppose (ii) holds. Then substituting $n = 4t + 1$ in $\lambda_1 = n(n-3)^2/4(n-2)$, we get $\lambda_1 = 4t^2 - 2t - (2t-1)/(4t-1)$, which is again fractional for all positive integral values of t. Hence the given design cannot exist.

APPENDIX 4.3

To show that a L_2 design with parameters satisfying the relation $v = 2k$, where k is an odd integer, cannot exist.

Proof. As $k = v/2 = s^2/2$, it follows that s must be even. Then, k is also even, which contradicts the fact that k is an odd integer. Hence the given design cannot exist.

APPENDIX 4.4

To show that a rectangular design with parameters satisfying relations $\theta_1 = 0 = \theta_2$, $b = p + r$ and $v = 2k$, where k is an odd integer, cannot exist.

Proof. As $v = 2k$, therefore $b = 2r$. But $b = p + r$, hence $r = p$. Also $k = v/2 = v_1v_2/2$. Using this information, we have from Section 2.5 of Chapter 2, $\lambda_1 = (v_1-1)(v_2-2)/2$, $\lambda_2 = (v_1-2)(v_2-1)/2$ and $\lambda_3 = (v_1v_2 - v_1 - v_2 + 2)/2$.

As $k = v_1v_2/2$ and k is an odd integer, it follows that v_1 and v_2 cannot both be even. Also for the same reason v_1 nor v_2 can contain a factor 2^α where $\alpha \geq 2$. Hence, the following two alternatives are possible:

(i) v_1 is even and $v_1 = 2v_1'$, where v_1' and v_2 are both odd integers, or

(ii) v_2 is even and $v_2 = 2v_2'$, where v_2' and v_1 are both odd integers.

Under alternative (i), λ_2 is integral but λ_1 and λ_2 are fractional, which is an impossible situation; under alternative (ii), λ_1 is integral but λ_2 and λ_3 are fractional, which is also an impossible situation. Hence, the given rectangular design cannot exist.

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